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Economic Evaluation of Actual and Optimal Adjustments in Resource Use on 160-Acre Farms in West Central Ohio, 1956-1959

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FARM PRODUCTION ECONOMICS DIVISION
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OHIO AGRICULTURAL EXPERIMENT STATION

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J. R. TOMPKIN AND F. J. RAFELD*

SUMMARY

A cooperative study on farm adjustment in 9 West Central Ohio counties was conducted during the 1956-1959 period by the Economic Research Service, United States Department of Agriculture, and the Ohio Agricultural Experiment Station. Information for the 1956 crop year was obtained on 85 of 131 randomly drawn 160-acre owner-operated farms and data for 1957-1959 were collected on a sub-sample of 37 farms. The purpose of the project was to obtain an inventory of farm resources on these farms, a knowledge of how these resources were used, what adjustments the sample operators made to price and other stimuli, and to what extent profitable adjustments can and should be made on the sample farms and ultimately in the entire region.

The sample area lies in the Ohio portion of the midwestern corn belt. The 9 counties selected (Ohio has 88 counties) represent only 11.37 percent of total farmland in Ohio, but contain 13.75 percent of harvested cropland, 17.74 percent of the harvested corn acreage, 19.66 percent of the corn production and 21.14 percent of the hogs raised in the state.

Changes in farm size and farm numbers constituted the most significant adjustments made by the sample farmers. Many operators ceased farming, selling or renting their farms. Substantial farm enlargement through purchase and leasing took place in the area. Census figures also show that mean farm size in the sample area increased from 118.8 to 133.6 acres, or 12.5 percent, during the 1954-1959 period.

An adjustment was defined as a statistically significant change from the operators normal organizational or practices pattern, as a result of a decision by the operator. Adjustments were classified as follows: cropping, livestock, labor, machinery, technological, cost, improvements, and capital use. Several farmers made adjustments in

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the size of various crop or livestock enterprises but the net total change due to these adjustments was negligible because the individual increases and decreases tended to compensate. No appreciable short run shifts to price changes were made except in the case of spring farrowing in response to hog price fluctuations. Those operators who tended to react to sustained hog or beef price movements did so only in the third year of the price trend. Corn acreage declined somewhat during 1957 and 1958 as the Soil Bank alternative was available, but increased in 1959 when the Soil Bank program was withdrawn.

Machinery inventory value per crop acre generally decreased over the study period as many farmers curtailed machinery purchases after 1956. Many operators were already overinvested in machinery, with too few crop acres to justify ownership of the major harvesting machines. Capital equipment purchases and expenditure for custom machines correlated highly with current annual cash receipts.

Seventeen of the 25 sample farmers from whom complete 4-year records were obtained each made one or more technological adjustments. In all, 25 adjustments of this type were made during 1957 through 1959.

Significant cost adjustments were made by many of the operators during 1959. The average cost level of the group declined sharply from 1958 despite a gradual increase in the index of prices paid by farmers for production items.

Dairy farms averaged most adjustments per farm, with hog-type farms making the least number of significant changes. There was considerable variance in the group of sample farmers in number of adjustments made, with the distribution being approximately normal.

A multiple correlation was run with the various types of adjustments as dependent variables, and with 25 independent variates comprised of various factors postulated to have some probability of relationship with the dependent variables. Statistically significant relationships were isolated for each type of adjustment.

Total farm adjustments were significantly influenced by the amount of capital the operator had available, by the amount of reinvestment in the farm business and by the amount of current cash costs incurred.

Crop adjustments depended more on the operator's debt position and the amount of cash costs per productive man work unit (PMWU).

Livestock adjustments varied with the capital position of the operator, the change in hog and corn prices over the previous year, and the age and education of the operator.

Labor and machinery adjustments generally followed the degree to which the operator was willing to reinvest disposable income into the farm business.

Technological adjustments were influenced primarily by the capital position, a sustained rate of change in prices of livestock and livestock products, the level of current cash costs, and the reinvestment policy of the operator.

Cost adjustments were associated simply with the absolute level of current costs. The higher the cash costs became, the more likely were adjustments to take place. There is, of course, some reversibility in this in that costs of some types of adjustment are reflected in the cost level. Thus, the more of certain types of changes made by the farmer, the higher become the cash costs.

Improvements adjustments were related to the operator's capital position, the willingness of the operator to reinvest in the farm business, and the cost of such major improvements ingredients as lime and fertilizer. There was some evidence that a younger operator with sufficient capital is more likely to make major farm improvements than an older operator with the same amount of capital.

Capital use adjustments *i.e.* significant changes in either short term or long term debt-pattern—were highly correlated with current level of cash costs and with the amount of reinvestment the operator made.

The major characteristics associated with almost all types of adjustment were (1) the general capital or risk bearing position of the operator, including his net worth and equity position: (2) the policy of the operator in reinvesting available funds; and (3) the cost level of the operator. Non-economic factors generally acted as only slight deterrents to adjustment. The group of operators influenced by non-economic factors made fewer adjustments but the difference was not significant.

Shifts to increased fall or spring sow farrowings tended to follow the relative level of hog prices the preceding fall or spring, respectively.

An estimating equation was derived whereby number of adjustments an operator is likely to make during the coming year can be predicted with reasonable accuracy. This equation points out the factors associated with farm adjustments and also indicates that farmers tend toward cyclical organizational changes in that the sample operators tended to adjust in alternate rather than consecutive years.

Each sample farm was linear programmed with variable beef and hog prices. The number of changes in optimum plans, within a given

range of product prices, for a given farm seemed to serve as a very good measure of the degree of resource flexibility on that farm, correlating positively and significantly with amount of capital available and the size of the farm in terms of PMWU's.

The income difference between actual farm organization and programmed optimum resource allocation averaged $2,458 per year for the 1957-1959 period. These differences were associated significantly with increase in corn acreage, inclusion of more beef steers in the farm plan, feeding efficiency, cash cost efficiency, and general elimination or reduction of dairy enterprise on some farms. Substantial amounts of rotation pasture should have been diverted to hay ground. Poultry and sheep enterprises should have been eliminated on several of the sample farms. Some farms could have reduced capital necessary to produce a given level of income.

Resource rigidity and a weak capital position were strong obstacles to adjustment. Voluntary resource rationing by the operator and his lack of knowledge of costs and returns of alternative enterprises also tended to deter adjustment. Adjustments themselves frequently require other changes, thus increasing total adjustment cost enough to preclude any resource shifts. The cost structure of the individual farm was an important factor in the kind and number of adjustments that particular farmers could or would make.

Farms with strong capital positions and more animal units of livestock had higher total cash costs but lower cash costs per PMWU. These were the farms which had the greatest number of optimal areas in the farm price-map when the farm was linear programmed. These also were the farms most likely to make adjustments.

INTRODUCTION

In the post-war years of 1945-1952 the Index of Prices Received by farmers was higher than the Prices Paid Index. This created a favorable situation whereby many farmers could simply produce a large volume of products and profit from the margin. In the fall of 1952, however, the cost index surpassed the prices received index. This adverse relationship increased gradually after 1952. It has become necessary to reduce production costs per unit of product, to strive for top market prices, and to organize resource use in an efficient manner if an operator is to compete successfully in farming. Sheer volume of production is no longer sufficient to insure a high level of living for the farm family.

Against this background, the United States government has employed agricultural policies and programs to induce individual farmers to adjust their resource use to a pattern more consistent with demand, as expressed by the pricing system. To do this effectively, the program administrators need to know how farmers will react economically to given stimuli. It is felt that when these reactions are known, not only can better policies be formulated, but farmers themselves can make appropriate production changes when they are aware of the general response of other farmers.

OBJECTIVES

In 1956 the Farm Production Economics Division of the Economic Research Service, USDA, and the Ohio Agricultural Experiment Station inaugurated a cooperative research project in west central Ohio to obtain and provide economic information to help Ohio farmers make profitable adjustments in their farm organizations and to provide a research background for development and appraisal of farm programs. The specific objectives of the study, as outlined in the project proposal were:[1]

1. To obtain an inventory of farm resources in west central Ohio and a knowledge of how these resources are used.
2. To learn to what extent farmers do attempt to adjust their production to meet changes in product prices and production costs.
3. To determine how accurately farm operators estimate, prior to the production period, their prospective product prices, crop acreages, crop yields, and amounts of products to be sold during the coming year.
4. To find out how effectively farmers follow through on their pre-production period plans.
5. To evaluate how successfully prediction can be made as to the extent of production adjustments farmers are likely to make in response to certain incentives or motivations.

[1]Descriptive Research Bulletins 885 and 895, "Resource Use on Four Types of 160-Acre Farms in West Central Ohio, 1956" and "Resource Use on Selected Types of 320-Acre Farms in West Central Ohio, 1957" respectively, published by the Ohio Agricultural Experiment Station and the Economic Research Service, cooperatively, describe typical farm organizations, by size and type of farm, in West Central Ohio Objectives 2, 3, 4, and 5 have been discussed at some length in Ohio Agricultural Experiment Station Bulletin No. 936, "The Role of Operators' Expectations in Farm Adjustment." The present bulletin is primarily concerned with objectives 1, 2, 5, and 6 and includes the other three in the discussion only as is necessary to present a clearer adjustment picture. A subsequent report will be released dealing with adjustment on the 320-acre size farms.

6. To ascertain what conditions and what variables influence the nature and extent of profitable adjustments that individual farmers can and should make.
7. To evaluate the area implications of desirable adjustments in terms of total production and production changes of various farm products.[2]

THE PROJECT AREA

Description

A nine-county farming area in west central Ohio (Figure 1) was selected for the study because it represented the commercial farming area of the state comprising the eastern tip of the corn belt region. It was hoped that it might be combined with studies in other corn producing states to provide a regional evaluation of the corn belt.

The topography of the sample area varies from nearly flat to sharply rolling, with the gently rolling Miami brown silt loam and silty clay loam soils predominating. Rainfall averages about 38 inches a year. Hog, dairy, and general livestock farms are most numerous, but some units are operated as cash grain farms. Beef cow-calf, sheep, and poultry operations are minor supplemental enterprises on some farms, and a few operators derive a major share of their gross returns from fattening feeder cattle. Crop rotations vary from corn-small grain-meadow-meadow, to corn-corn-small grain-meadow, depending generally upon topography and the intensity and type of livestock production.

The relative agricultural importance of the nine-county project area is shown in Table 1 in the form of a comparison to state totals for Ohio for land use and production statistics. It can be seen that while the area comprises only 10.23 percent of the state's 88 counties, 11.37 percent of total farmland, and 11.18 percent of the farms in the state, it contributes a higher percentage of Ohio's agricultural production.[3]

The Sampling Method

The sample consisted of 150 owner-operated (or father-son partnerships) farms in the 140 to 180-acre size range.[4] The selected study area appeared to be sufficiently homogeneous in terms of climate, soils, and types of farming to preclude the need for stratification in the sampling design. A two-stage random sampling procedure was used.

[2]This objective can be treated only in a preliminary way in this report. A more comprehensive appraisal can be advanced only after analysis of other size groups of farms. This will be treated more fully in a subsequent publication.

[3]For detailed farm organization, costs and income on typical 160-acre farms in the selected area, see Ohio Agricultural Experiment Station Bulletin 885, "Resource Use on Four Types of 160-Acre Farms in West Central Ohio, 1956" by J. R. Tompkin.

[4]The sample 140-180 acre farms will be referred to as 160-acre farms in the remainder of this bulletin.

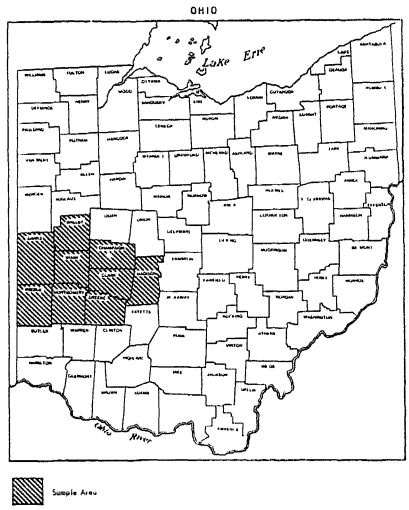


Fig. 1.—Counties included in the project.

The primary sampling units were townships. The ASC records were used to identify those farms which met the sample requirements in each sample township. These farms were then arrayed by number and 150 were drawn, taking from each township that number of sample farms corresponding to the proportion of the township's owner-operated 160-acre farms to the total owner-operated 160-acre farms in the sub-sample of townships. This assured all farms in the size range and with this tenure type an equal chance of being drawn.

It was estimated that about one farm in seven might be ineligible for 160-acre grouping due to failure of ASC records to show associated tracts located in other townships or counties, or might be lost through refusal of the operator to cooperate. For these reasons, 21 replacement farms were drawn to be used if needed. Townships including the cities of Dayton, Springfield, Piqua, and Sidney were deleted because of the extreme influence of urbanization. The restriction of the sample farms to owner-operator or to father-son type operations was an attempt to reduce variation due to tenure.

The 150 sample farms were visited in the spring of 1956. Eighty-six of the 171 sample and replacement farms were ineligible because of errors in tenure, farm size, refusal, tract omission, or because the operator had ceased farming. This left a total of 85 farms on which a schedule was completed.

Collection of Data

Information was obtained from each of the 85 eligible operators as to resource inventories, farm organization, practices, production inputs and outputs, costs and indebtedness. Each operator was also

TABLE 1.—Comparison of the Area Studied to State Totals of Land Use and Crop and Livestock Production, 1956.[1]

Item	Unit	State Total	Sample Area	
			Total	Percentage of State Total
Number of Counties	Co.	88	9	10.23
Number of Farms	No.	162,000[2]	18,105	11.18
Farmland	Acre	19,400,000[2]	2,205,000	11.37
Average Size of Farm	Acre	120.5[2]	121.8	——
Cropland	Acre	12,570,000[2]	1,721,000	13.69
Cropland Harvested	Acre	10,638,540	1,463,200	13.75
Land in Harvested Crops:				
Corn	Acre	3,523,000	625,000	17.74
Soybeans	Acre	1,301,000	154,900	11.91
Wheat	Acre	1,496,000	203,900	13.63
Oats	Acre	1,101,000	189,300	17.19
All Hay	Acre	2,244,000	273,500	12.19
Crop Production:				
Corn	Bu.	211,380,000	41,555,000	19.66
Soybeans	Bu.	31,224,000	3,857,000	12.35
Wheat	Bu.	38,896,000	5,055,000	13.00
Oats	Bu.	47,343,000	9,019,100	19.05
All Hay	Ton	3,860,000	500,000	12.95
Average Crop Yields:				
Corn	Bu.	60.00	66.50	——
Soybeans	Bu.	24.00	24.90	——
Wheat	Bu.	26.00	24.80	——
Oats	Bu.	43.00	47.60	——
All Hay	Ton	1.72	1.83	——
Estimated Numbers of Livestock on Farms January 1, 1956				
All Cattle and Calves	Head	2,393,000	324,400	13.56
Milk Cows and Heifers	Head	892,000	103,400	11.59
Hogs, Including Pigs	Head	2,836,000	599,600	21.14
Stock Sheep	Head	1,036,000	122,400	11.81
Chickens	Head	14,298,000	1,634,000	11.43

[1]Unless indicated otherwise these data are taken from, or computed from, Ohio Agricultural Experiment Station Bulletin "Ohio Agricultural Statistics 1955 and 1956" by Pallesen, J. E., and Houghton, Eldon, of the Agricultural Marketing Service, USDA, and Smith, M. G., and Tejada, G. A., of the Department of Agricultural Economics and Rural Sociology, Ohio Agricultural Experiment Station, Wooster, Ohio.

[2]Values interpolated from the 1954 and 1959 U.S. Census of Agriculture for Ohio

asked the amount of acreage he expected to plant to each crop in 1956, what yields he expected to receive, what livestock he intended to produce, the amounts of each product he expected to sell during 1956, the month of sale, and the prices he expected to receive for the products sold.

The data obtained on this first enumeration were used as background information on 160-acre owner-operator farms in west central Ohio, and also for compiling an inventory of resources on the sample farms.

Inventory of Resources, January 1, 1956

Total amounts of land and cropland on the sample farms January 1, 1956, as reported by the operators, were compared with the census report of all 160-acre farms in the area. This is shown in Table 2. The 85 sample farms constitute 9.16 percent of the 928[5] owner-operated 160-acre farms in the nine counties.

The capital resources, exclusive of land value, on the sample farms as of January 1, 1956, amounted to about $2.65 million, or over $31,000 per farm. These estimates were derived using current market values and appraised values as determined by the authors. The distribution of capital assets is given by type-of-farm classification in Table 3.

The debt patterns of the selected operators are shown in Table 4, with a breakdown into short term indebtedness, amount of real estate mortgage, and percentage of operator's equity in capital assets.

[5]Computed from U.S. Agricultural Census for Ohio for 1954 and 1959.

TABLE 2.—Comparison of Numbers and Acreage of Sample Farms, and All Farms, 140-180 Acre Range in the Nine-County Selected Area.

Item	(A) In Sample	(B) In 9 County Area[1]	(C) Percentage Col. (A) is of Col. (B)
No. owner operated 160-acre farms[2]	85	928	9.16
No. of all 160-acre farms	85	2,015	4.22
Acreage of farmland in owner-operated 160-acre farms	13,785	148,480	9.28
Acreage of farmland per 140-180 acre farm	162.2	164.4	——
Acreage of cropland per 140-180 acre farm	124.4	128.3	——

[1]Taken from or derived from U.S. Census of Agriculture for Ohio, 1954 and 1959.
[2]Owner-operated farms, as used in this report, include only farms on which at least 90 percent of the land is owned by the operator.

TABLE 3.—Inventory of Capital Resources Excluding Land, on Sample 160-Acre Farms, Jan. 1, 1956 by Type of Farm.[1]

Type of Farm	No. of Farms	Total Capital Resources		Value of Buildings and Improvements		Value of Machinery and Equipment		Value of Livestock		Value of Feed	
		Total	Per Farm	Average Per Farm	Percent of Capital Resources	Average Per Farm	Percent of Capital Resources	Average Per Farm	Percent of Capital Resources	Average Per Farm	Percent of Capital Resources
		(000)	(Dollars)	(Dollars)	(Percent)	(Dollars)	(Percent)	(Dollars)	(Percent)	(Dollars)	(Percent)
Dairy	19	$648.2	34,115	20,056	58.8	5,297	15.5	5,509	16.2	3,253	9 5
Hog	19	517.3	27,228	16,488	60.6	4,672	17.2	3,851	14.1	2,217	8.1
Beef[2]	5	145.5	29,099	18,922	65.0	4,713	16.2	3,493	12.0	1,971	6 8
General Livestock	26	848.1	32,619	19,652	60.3	5,463	16 7	4,347	13 3	3,157	9 7
Cash Grain	16	494.9	30,931	19,773	63.9	6,912	22 4	1,435	4 6	2,811	9 1
Total Farms	85	$2654.0	31,224	$19,015	60.9	$5,478	17.5	$3,898	12 5	$2,833	9.1

[1]Type of farm was determined by percentage of total gross receipts contributed by the various enterprises. For example, if more than 50 percent of gross receipts came from the dairy enterprise, the farm type was dairy If more than 50 percent from hogs or from cash grain, the farm was a hog farm or a cash grain farm, respectively. Where no enterprise contributed as much as 50 percent of gross receipts, the farm was classified as a general livestock farm.

[2]Two of these farms were cow-calf operations and the other 3 were beef-feeder farms in 1956. The gross receipts from beef over the 1956-1959 period diminished to less than 50 percent of total so these farms were reclassified to other farm types after 1956.

TABLE 4.—Summary of Indebtedness, by Farm Type on 85 Sample Farms, January 1, 1956.

Type of Farm	Number of Farms	Value of Total Assests Per Farm	Real Estate Mortgages		Non-Real Estate Indebtedness		Average Equity All Farms
			Number Farms	Average Size of Mortgage	Number Farms	Size of Loan Per Borrowing Farm	
		(Dollars)		(Dollars)		(Dollars)	(Percent)
Dairy	19	56,410	11	7,247	13	1,742	90 45
Hog	19	52,940	6	6,250	7	2,457	94 56
Beef[1]	5	52,777	2	18,000	3	2,833	83 14
General Livestock	26	57,256	6	2,737	10	1,980	97 57
Cash Grain	16	57,039	6	6,200	3	1,367	95 48
Total	85	$55,798	31	$ 6,672	36	$2,007	94 12

[1]See footnote 2 in Table 3

Factor Use on Sample Farms in 1956

After the initial enumeration of 85 sample farms in the spring of 1956, a sub-sample of 37 farms was drawn. These operators were visited each March through 1960 and production, resource allocation, and income information obtained for the previous year. This sub-sample of farms was tested for homogeneity with the larger sample by group comparison methods to confirm its representativeness of the larger sample.

The use of the available production factors on the 37 sub-sample farms during 1956 was divided into crop and into livestock production uses. The acreage in various crops, average yields, total production, and feed disposition data are shown in Table 5. Comparable data for livestock have been placed in Table 6.

Labor requirements per farm were computed using standard rates of performance per productive man work unit. These requirements were then compared with the labor available, using the length of working day in the busy and slack periods as reported by the operators.

The highest monthly labor requirement occurred in October on 40 percent of the farms. April and June required most labor on 28 and 20 percent, respectively. October and April were the critical labor months on 72 percent of the farms, with June and May showing most labor shortage on the balance of the farms. Surplus operator and unpaid family labor in the amount of 436 hours per year per farm indicated that, as a group, these farms had plenty of labor to meet non-peak requirements. Operators hired an average of 244 hours per farm during the peak labor seasons.

During 1956, five of the 37 sub-sample operators worked at full time off-farm jobs and eight others reported working off-farm 50 to 100 days during the year. Twelve farmers in the group had sufficient time to have worked 40 hours per week at another job had they wished to do so and provided the work was available.

PROCEDURE AND BULLETIN ORGANIZATION

The reader has thus far been given the purposes of the research study, a brief comparison of land use in the nine-county sample area with that of the entire state, the method used to draw the sample farms, the type of information obtained from the selected operators, an inventory of resources on 85 sample farms as of January 1, 1956, and the 1956 factor use on a sub-sample of 37 farms. The remainder of this section describes the order and the content of the rest of this bulletin.

Farm size adjustments will be discussed including how size changes influenced the drop from 171 original farmers to 85 complete records,

TABLE 5.—Resource Use in Major Crop Production on 37 Subsample Farms in 1956, by Type of Farm.[1]

Item	Unit	9 Dairy Farms	9 Hog Farms	5[2] Beef Farms	8 General Livestock Farms	6 Cash Grain Farms	37 Total Farms
Farmland	acre	1421	1414	760	1287	964	5846
Cropland	acre	1149	1157	560	970	806	4642
Corn:							
acres	acre	327	525	182	316	291	1641
production	bu.	21969	39800	11556	22749	21356	117430
yield	bu.	67	76	63	72	73	72
fed	bu.	10996	27102	7197	10944	2121	58360
sold	bu.	5685	10298	2357	13240	19416	50996
Wheat:							
acres	acre	141	132	33	95	93	494
production	bu.	3242	2771	1117	2288	2449	11867
yield	bu.	23	21	34	24	26	24
fed	bu.	643	227	0	196	380	1446
sold	bu.	2937	3924	650	1425	3486	12422
Soybeans:							
acres	acre	18	40	18	61	132	269
production	bu.	432	989	485	1839	3876	7621
yield	bu.	24	25	27	30	29	28
sold	bu.	400	1078	485	1390	2129	5482
Oats:							
acres	acre	120	100	90	124	71	505
production	bu.	6680	4751	5424	6425	2978	26258
yield	bu.	56	48	60	52	42	52
fed	bu.	5624	5392	2688	6808	112	20624
sold	bu.	0	53	2028	1616	2716	6413
Hay:							
acres	acre	295	125	66	176	76	738
production	ton	857	233	117	500	139	1846
yield	ton	2.9	1.9	1.8	2.8	1.8	2.5
fed	ton	814	200	138	428	70	1650
sold	ton	0	30	0	38	39	107
Acres Rotation Meadow	acre	190	214	150	177	103	834
Acres Permanent Pasture	acre	123	85	95	132	41	476

[1]Thirty-seven 160-acre owner-operated farms represent a 3.99 percent sample of the estimated 928 owner-operated 160-acre farms in the 9-county area.

[2]See footnote 2 in Table 3.

TABLE 6.—January 1, 1956, Livestock Inventory, Amount and Value of Livestock and Livestock Products Sold on 37 Subsample Farms During 1956.

Item	Unit	9 Dairy Farms	9 Hog Farms	5[1] Beef Farms	8 General Livestock Farms	6 Cash Grain Farms	37 Total Farms
Dairy cows on hand 1/1/56	cow	210	25	1	75	8	319
All other cattle on hand 1/1/56	head	94	109	128	109	34	474
Dairy calves sold in 1956	head	109	14	0	31	5	159
Value	dollars	1872	207	0	1269	238	3586
Fat cattle sold in 1956	head	4	46	132	28	3	213
Value	dollars	500	5655	22392	3974	498	33019
All other cattle sold in 1956	head	49	4	0	24	4	81
Value	dollars	5909	277	0	3928	446	10560
Cwt. milk sold in 1956	cwt.	11361	1171	0	3840	396	16768
Value	dollars	45151	4031	0	4626	982	64790
Hogs: sows on hand 1/1/56	sow	37	155	9	76	0	277
Other hogs on hand 1/1/56	head	95	734	66	190	9	1094
No. fat hogs sold in 1956	head	186	1657	367	549	21	2780
Value	dollars	6598	52066	12445	17808	896	89813
Other hogs sold in 1956	head	25	93	9	77	0	204
Value	dollars	1095	5075	588	2893	0	9651
Stock sheep on hand 1/1/56	head	40	115	43	103	0	301
No. lambs sold in 1956	head	10	144	20	70	0	244
Value	dollars	140	2527	384	1074	0	4125
Other sheep sold in 1956[2]	head	12	2	0	0	0	14
Value	dollars	116	8	0	0	0	124
Pounds wool sold in 1956	pound	345	1275	355	860	0	2835
Value	dollars	131	543	176	358	0	1208
Hens on hand 1/1/56	hen	275	1025	190	780	120	2390
No. chickens sold in 1956	head	195	1080	77	545	100	1997
Value	dollars	153	929	63	538	46	1729
No. dozens eggs sold in 1956	dozen	4943	15626	2725	13123	1430	37847
Value	dollars	1691	5951	932	4474	500	13548

[1]See footnote 2 in Table 3.

[2]Those cases where a ram was bought and a ram was sold during the year are not included.

and how the 37 farm sub-sample diminished to 25 complete records for the 1956 through 1959 period.

The complete 4-year records will be used to show the various kinds of actual adjustments made by the 25 sample operators during 1957-1959. Adjustments in 1956 have been omitted because 1955 data were not available for comparison.

Total adjustments made by the operators will be categorized into various types and multiple correlation procedure used to identify factors associated with each type of adjustment. The relationship of non-economic factors with adjustment is also investigated. An estimating equation for predicting numbers of adjustments per farm was derived, tested, and the results shown graphically.

Another section of this report will discuss how the 25 sample farms were variable-price programmed and the results price-mapped for each farm. Comparisons of the programmed optimum allocations with the operators' actual organizations will be presented, along with the adjustments necessary to approximate the optimum solution. The income differences between actual and programmed organizations will also be brought out.

A section on obstacles to adjustment will precede a section on conclusions.

FARM SIZE ADJUSTMENTS

For the purposes of this study the term "adjustment" is defined as a statistically significant departure from the operators' 1956-1960 normal pattern of organization or operation, made as a result of a decision by the operator. Where no normal pattern of organization or operation was discernable, a change was not considered as an adjustment unless it was of such magnitude that the intent of the operator was clearly evident. Thus the number of adjustments isolated in the analysis should be considered as a minimum measure.

Changes in farm size constitute the most important type of adjustment made by the sample farmers during the 1956-1959 period and in the year preceding drawing of the sample. The reader will recall that only 85 complete records were obtained for 1956 from the 171 regular and replacement farms drawn for the sample. Of the other 86 farms, 40 were ineligible for inclusion, 8 operators preferred not to cooperate, and 38 farms had changed size between 1955 and 1956 so that they were no longer within the 140-180 acre size range. The breakdown of these 38 farms was: 14 operators rented additional land, 3 farmers purchased more land, 4 operators rented out a portion of the farm, 14 operators ceased farming and rented out their entire farms, and 3

owner-operators sold their units. Thus 13 percent of these farmers increased farm size, 3 percent reduced acreage operated, and 13 percent dropped out of farming completely between 1955 and 1956.

Farm enlargement and going out of farming continued to be major forms of adjustment in the sub-sample of 37 farms selected for continued enumeration in 1957, 1958, and 1959. Five operators enlarged their farm acreage, four others quit farming, and three operators dropped out for personal reasons. This left 25 farms in the 140-180 acre size range for which complete 4-year records were obtained. The balance of this report is based on these 25 farms on which no farm size adjustments were made. This sample group is assumed to be representative, therefore, of a population of 160-acre farms rather than of a population of various sized farms.

OTHER ADJUSTMENTS ON 25 SAMPLE FARMS, 1957-59[6]

Adjustments in Land Use

To determine adjustments in land use, statistically significant additions or reductions in crop acreages from the year to year cropping pattern were noted. The results are shown in Table 7.

It can be seen in Table 7 that acreage adjustments tended to cancel out over the 3-year period. From 1957 through 1959, corn showed a net increase of 33 acres whereas soybeans declined 27 acres during the same period. The total grain and hay acreage increased only nine acres during the period. Timeliness factors, seeding deficiencies and some soil bank participation were the primary reasons reported by the operators. From this data it must be concluded that crop acreage adjustments for the sample farms, as a group, did not show any longer period swing away from any particular crop enterprise. Individual farm crop acreage adjustments tend to compensate for each other.

Multiple correlations were run for each year of the 1957-1959 period to determine what other crop acreage increased or decreased as corn acreage adjustments were made. Corn acreage difference per farm from year to year was used as the dependent variable. Successive year acreage differences in oats, soybeans, wheat, hay, and rotation pasture were the 5 independent variables. The multiple correlation coefficients for 1957, 1958, and 1959 were $R = .77$, $R = .79$, and $R = .91$, respectively. In 1957 corn acreage decreased by 150 acres on the 25 sample farms while diversion to soil bank amounted to 98 acres, soybean acreage increased 43 acres, and oat acreage dropped 73. The correlations indicated that most of the corn acreage decrease went

[6]Adjustments in 1956 have been omitted because 1955 data were not available for comparison

TABLE 7.—Significant Crop Acreage Adjustments on Sample 160-Acre Farms, by Crops, 1957-59.[1]

Crop	1957			1958			1959			Net Acreage Increase 1957-59
	Number of Adjustments	Total Acreage Changed	Net Acreage Increase	Number of Adjustments	Total Acreage Changed	Net Acreage Increase	Number of Adjustments	Total Acreage Changed	Net Acreage Increase	
Corn	6	120	—120	3	72	20	6	175	133	33
Oats	1	28	— 28	3	53	3	6	108	50	25
Soybeans	0	—	—	3	52	—12	3	81	—15	—27
Wheat	5	95	17	4	58	—22	3	43	7	2
Hay	7	160	10	4	93	—39	3	49	5	—24
Corn Soil Bank	1	28	28	1	28	28	2[2]	56	—56	0
Wheat Soil Bank	4	81	81	2	31	—31	3[2]	50	—50	0

[1]Acreage adjustments within a given crop enterprise may be an increase or decrease of acreage of that crop for that year. In some cases a farmer might increase acreage of one crop and decrease acreage of another crop. This is included as two separate adjustments. Only statistically significant changes are classified as "adjustments".

[2]The soil bank alternative for corn or wheat ground was not available in 1959 so all acreage diverted in 1958 reverted to crop use in 1959

to soil bank and rotation pasture. The oat acreage decrease went primarily to soybeans. In 1958, corn acreage increased 76 acres while rotation pasture decreased 64 acres. This relationship of $r = -.522$ was significant at the .01 probability level. In 1959, corn increase of 123 acres correlated with soybean acreage decrease ($r = -.84$) at the .01 level. However, while most of the diverted acreage of soybeans returned to corn, the total acreage involved was small. Most of the corn acreage increase came from return of soil bank acres into cropland inasmuch as the soil bank diversion alternative was not available to farmers in 1959.

The overall conclusion must be that as corn acreage fluctuated downward, the acreage removed went primarily to soil bank and meadow. As corn acreage increased, soil bank and rotation pasture acreage declined.

Mean annual acreage indexes of each crop raised on the 25 sample farms are plotted in parts A, B, C, D, and E of Figure 2, along with the index of average Ohio quarterly prices of the product. The seasonal price fluctuations have been modified by using the mean of the 1950-1962 quarterly prices as the base of 100. The enterprise size index has 1956 = 100. Corn acreage decline in 1957 and increase in 1958 and 1959 are generally associated with degree of soil bank participation. None of the crop production curves in Figure 2 show much response to price changes.

Adjustments in Livestock Production

Increases or decreases in the size of livestock enterprises on the sample farms assumed somewhat the same pattern as was shown for crop enterprises. Enterprise adjustments of some operators tended to be off-set by the changes of other farmers. Significant enterprise size adjustments, including additions and deletions, are presented in Table 8. Beef feeder, poultry, and fall pig enterprises showed adjustment on 7, 8, and 7 farms, respectively, during the 1956-1959 period. Poultry had a net gain of only about 50 hens. Adjustments in numbers of feeder cattle about off-set each other over the period. Fall pigs farrowed showed a net loss of 7 sows during 1957-1959. Dairy cows also showed a net loss in numbers during the period.

Livestock Enterprise Substitution

Multiple correlations were run for each year to determine substitutions occurring in livestock enterprise adjustments. Successive annual differences in numbers of sows fall-farrowed per farm were used as the dependent variable and successive annual differences per farm in

Fig. 2.—Indexes of Enterprise Size and Product Prices, 1956-59, on 25 Sample Farms

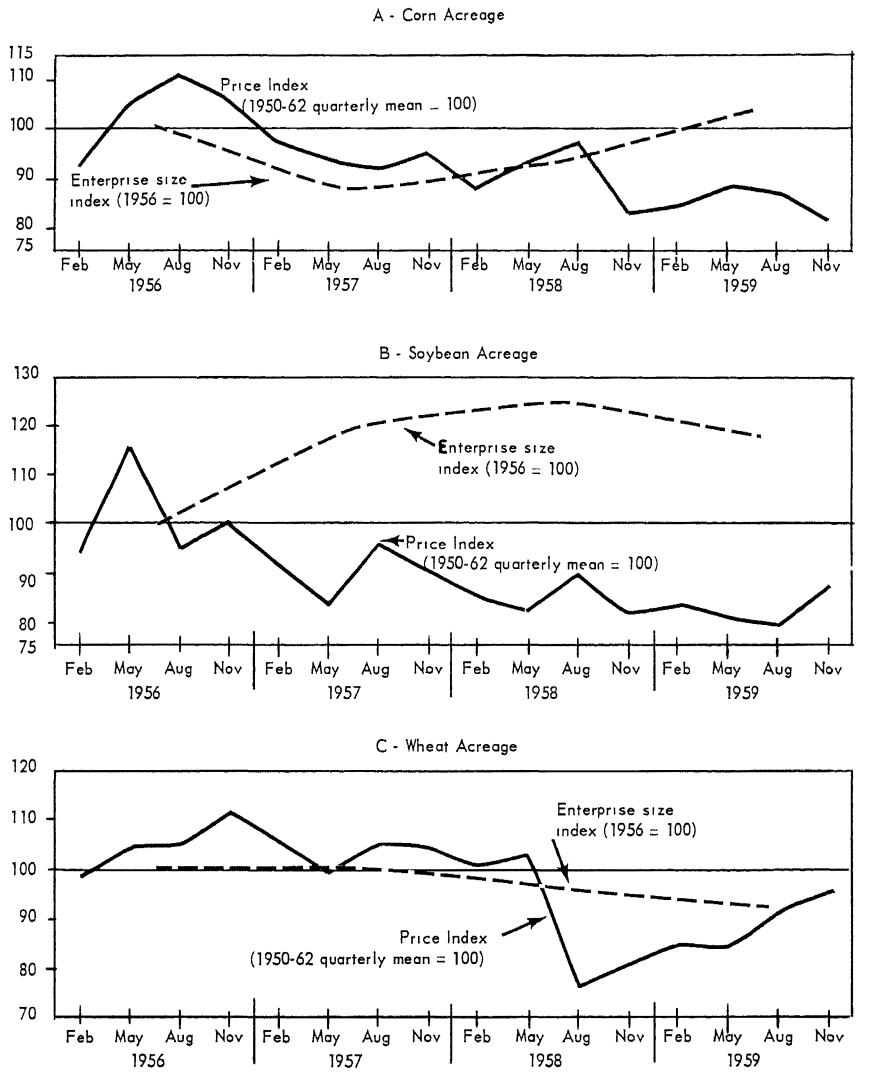


Fig. 2.(Continued)—Indexes of Enterprise Size and Product Prices, 1956-59, on 25 Sample Farms

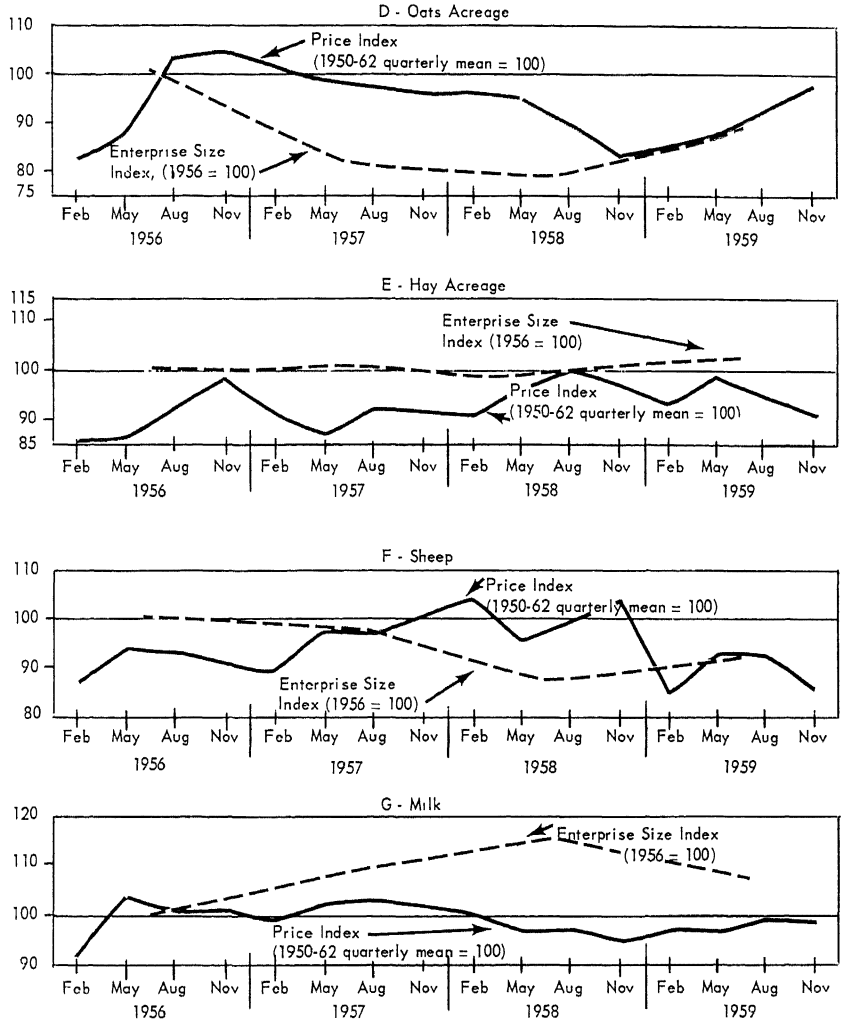
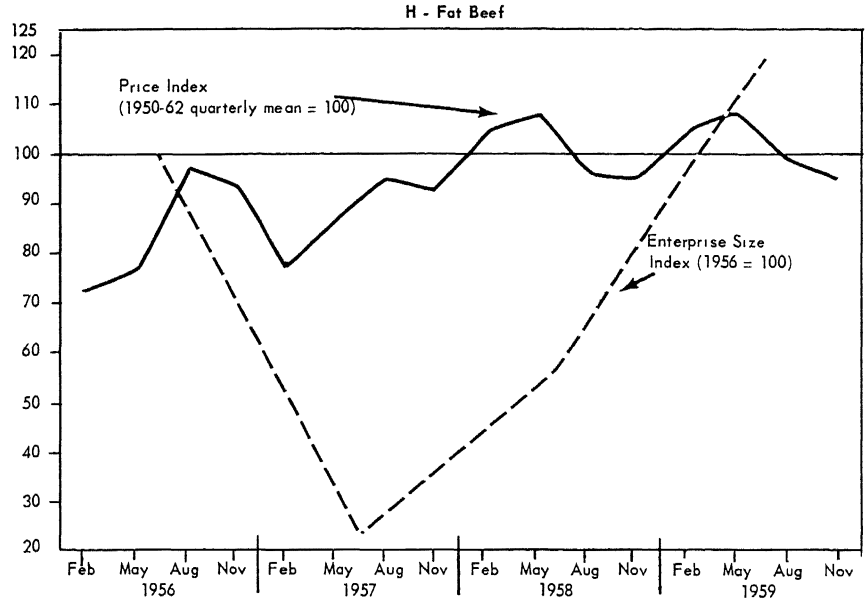


Fig. 2. (Continued)–Indexes of Enterprise Size and Product Prices, 1956-59, on 25 Sample Farms



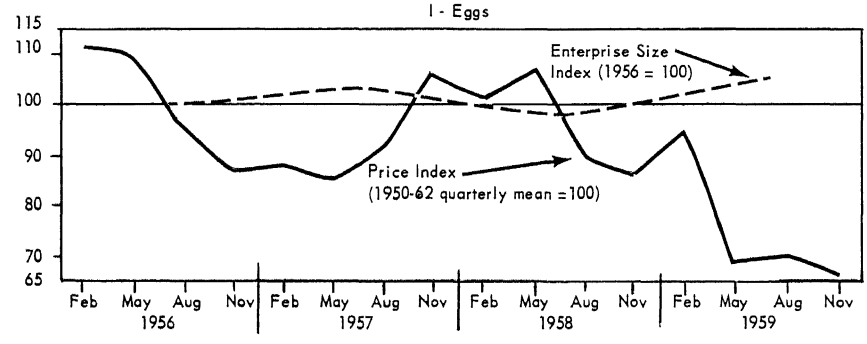
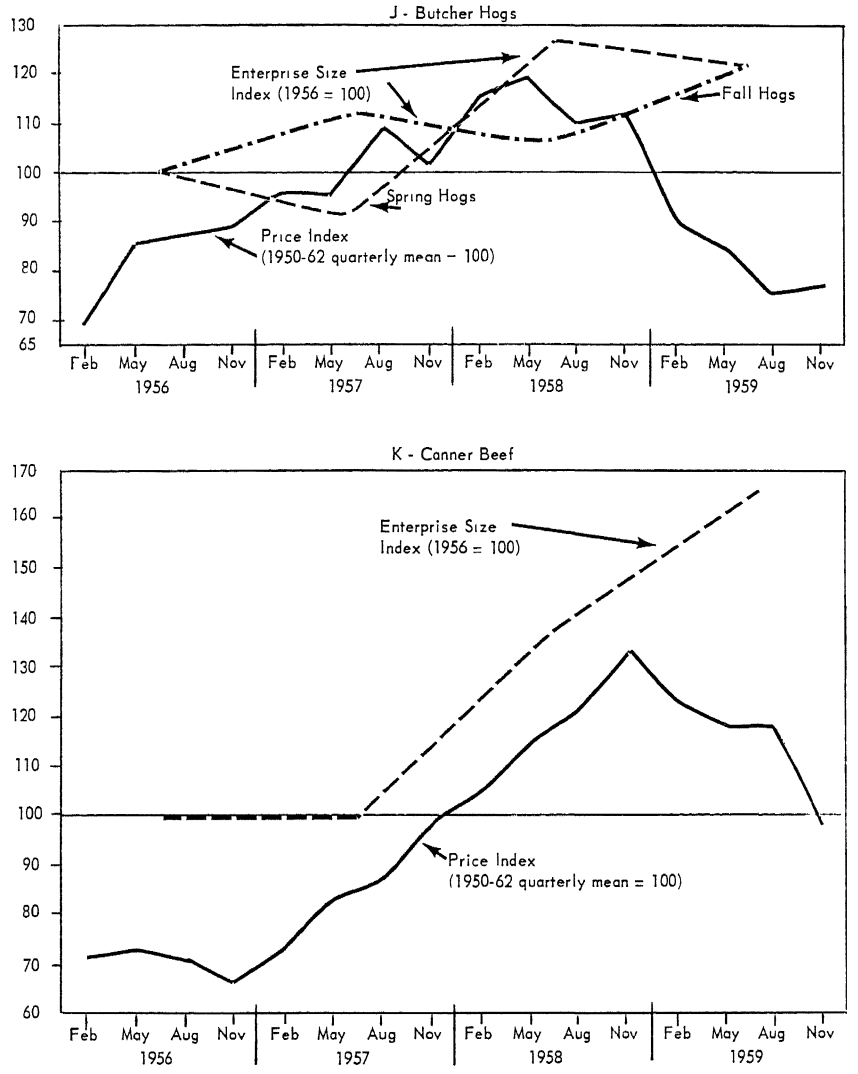


Fig. 2. (Continued)–Indexes of Enterprise Size and Product Prices, 1956-59, on 25 Sample Farms



numbers of dairy cows, beef cows, beef feeders, ewes, hens, and spring-farrowed sows constituted the six independent variables. In a second model the same variables were used except that fall-farrowed and spring-farrowed sows were interchanged. In 1957 no substitution relationship was discernable, with a multiple R of only .29. The R's in 1958 and 1959, however, were .56 and .79, significant at the .01 level. In 1958, an inverse relationship between numbers of spring and fall sow farrowings appeared ($r = -.52$). This was significant at the one percent level. Checking the original data it was observed that spring sows increased and numbers of fall sows decreased, although not as much as the increase in spring farrowings. This relationship was probably caused by a high price of $19 to $20 per hundredweight for hogs in the fall of 1957 whereas the price had been $15 to $16 in the fall of 1956. The same correlation in 1959 was observed to be $r = -.70$, with fall sow farrowings increasing and spring farrowings decreasing. This relationship was statistically highly significant. The price of fall hogs in 1958 had remained high at about $20, but the 1958 spring price had been about $21. These data suggest that shifts to increase fall or spring farrowings follow the relative level of hog prices the preceding fall or spring.

Livestock production adjustments conformed fairly closely to average annual product prices in the cases of the spring hog and beef enterprises, but no adjustment attempt by the group is clearly noticeable for the other livestock enterprises (see F, G, H, I, J, and K of Figure 2).

Adjustment in Time of Selling Products

Only nine operators who sold corn had a discernable seasonal selling pattern and five of these deviated from the pattern by a month or more at some time during the four-year period. Nine operators normally sold soybeans at harvest time and one usually sold in the spring. One of the 9 and the "spring seller" deviated once during 1957-1959. Fourteen wheat growers sold at harvest time in 1956 and 1957, but four shifted selling time in 1958 and four others did so in 1959.

Livestock producers showed more pattern in time of sale, and adhered more closely to it than was true with crop sales. The beef producers all sold in the spring. Eleven of the 16 operators farrowing pigs in the spring were quite consistent in selling time. During 1957-1959 three operators sold a month or more earlier than usual and 3 sold a month or more later than their normal practice. Ten of the 15 operators raising fall pigs showed only a total of 2 significant adjustments in selling dates. No reliable adjustment patterns were discernable for selling times of sheep or poultry.

Adjustments in Weights of Livestock Sold

Fat beef were sold by most operators at 900 to 1000 pounds. One farmer sold consistently at 1100 to 1200 pounds. In the four-year period studied, the only adjustment was one sale of mixed heifers and steers at 200 pounds below the normal 900 pound selling weight. Apparently the operator decided to sell as stockers rather than as fat beef.

Thirteen of the operators selling hogs in the spring sold at the same weight each year and 15 normally sold at a given weight in the fall. During 1957-1959 ten lots of hogs sold in the fall averaged from 25 to 50 pounds per hog more than the usual selling weight. Five operators shifted to sale of feeder pigs in 1959. One farmer sold weaner pigs in 1958. The 15 operators whose sale weights in the fall were generally uniform sold 5 lots of hogs at 25 to 50 pounds heavier weights during the 3-year period. One operator sold at 45 pounds under his normal selling weight. Another lot was sold at 100 pounds.

The sale of heavier hogs was probably in response to the generally favorable corn-hog ratio from 1956 through 1958. The increase in sale of feeder pigs in 1959 might well have been due to the sharp decline in fat hog prices that year.

Total livestock adjustments included statistically significant changes from normal patterns in enterprise size, month of sale, and selling weight. Thirteen adjustments were made on 9 farms in 1957, 15 on 11 farms in 1958, and 22 on 10 farms in 1959.

Adjustments in Debt Patterns

The 25 sub-sample operators from whom records were obtained through January 1, 1960, were examined for capital adjustment by means of change in debt pattern. Average indebtedness for these farms is shown in Table 9. One new real estate mortgage was added during 1956. Average size of land mortgage gradually decreased from 1956 through 1959 except during 1957 when one operator in the group added to an existing land mortgage.

Short term indebtedness per farm tended to increase each year until 1959. Significant short term debt adjustments totaled $4045 debt increase on 25 sub-sample farms, with 18 separate adjustments involved (Table 10). Dairy farmers increased short-term liabilities considerably more than other operators whereas hog type farm operators adjusted generally downward in debt size. Table 10 shows also that adjustment in debt size was upward during 1956 and downward during 1957.

TABLE 8.—Significant Livestock Enterprise Size Adjustments on Sample 160-Acre Farms, by Kinds of Livestock 1957-59.[1]

Kind of Livestock	1957			1958			1959			Net Number Head Increase 1957-59
	Number of Adjustments	Number Head Changed	Net Number Head Increase	Number of Adjustments	Number Head Changed	Net Number Head Increase	Number of Adjustments	Number Head Changed	Net Number Head Increase	
Dairy Cows	1	10	10	1	12	— 12	2	22	— 8	—10
Beef Feeders	3	38	—38	2	11	11	2	28	28	1
Spring Farrowed Sows	4	41	—27	1	22	22	1	5	5	0
Fall Farrowed Sows	2	12	0	1	6	6	4	27	—13	— 7
Ewes	0	—	—	2	26	— 14	1	6	— 6	—20
Hens	2	150	150	3	258	—148	3	195	51	53

[1]Where an operator significantly increases number of livestock in one enterprise and significantly decreases numbers in another enterprise, one adjustment is shown for each of the two changes.

TABLE 9.—Average Indebtedness on 25 Sample Farms, January 1, 1956 Through January 1, 1960.

Type of Indebtedness	Number of Borrowing Farmers and Their Average Indebtedness as of January 1									
	1956		1957		1958		1959		1960	
	Number Farms	Average Debt	Number Farms	Average Debt	Number Farms	Average Debt	Number Farms	Average Debt	Number Farms	Average Debt
Real Estate	12	$7189	13	$6354	13	$6746	13	$6227	13	$6140
Short Term	13	2142	16	2275	11	2026	14	3082	14	2539

TABLE 10.—Significant Short Term Debt Adjustments on 25 Sample Farms, 1956-59.

Item	During Calendar Year of			
	1956	1957	1958	1959
Number of Adjustments	2	5	6	5
Total Change	$4460	$16,175	$19,130	$10,570
Net Debt Increase	4460	—13,775	19,130	—5,770
Total Net Debt Increase During 1956-59 Period = $4045				

Real estate loans on 5, 3, 2, and 3 farms were obtained from the Federal Land Bank, the local commercial bank, from private sources, and from savings and loan associations, respectively. An insurance company held one mortgage and the Farmers Home Administration held one. Two operators refinanced with another lending agency during the period.

Local banks financed 11 operators on short-term loans. Five operators secured funds from the PCA, 2 borrowed from private sources, and one obtained financing through the implement company. Again, two operators refinanced with other agencies.

Capital adjustments involving significant changes in debt pattern totaled 6 on six farms, 6 on six farms, and 5 on five farms for 1957, 1958, and 1959, respectively.

Adjustments in Labor

Farmers reported a consistent average of about 10.8 and 6.1 hours worked per day by the operator during the busy and slack seasons, respectively. The twenty-five sub-sample farmers reported an average of 3.1, 2.3, 2.9, and 2.8 man-months of unpaid family labor in addition to the operator's labor during 1956, 1957, 1958, and 1959. Six operators had significant changes in amount of family labor in 1957, with a decrease on 5 farms and a labor increase on the other. Substantial increases in family labor occurred on 2 farms in 1958.

One sample operator hired a full-time man in 1956 and 1957. All operators hired some seasonal labor during peak work periods, averaging 16.3 days per farm in 1956, 16.0 days in 1957, 23.7 days in 1958, and dropping slightly to 22.5 days per farm during 1959.

The total PMWU's were computed for each farm, for each year, and divided into the annual hours of labor per farm. The average of all farms for 1956-1959 was 11.7 hours labor per PMWU, ranging

from 12.16 in 1956 to 11.35 in 1957. This was fairly consistent with the commonly accepted standard rate of 10 hours per PMWU.

Eight farms showed significant change in labor efficiency as reflected by variation in hours of labor used per PMWU. It can be seen in Table 11 that four adjustments resulted in increased labor efficiency, whereas the other four increased the number of hours used per PMWU. The attendant adjustments are also shown in Table 11 for each adjusting farm during the year the shift was made. Changes in labor available and in numbers of productive man work units of labor needed were the primary types of adjustments. In three cases the operators decreased the amounts of off-farm work. In another instance, the farmer increased amount of off-farm work.

Labor adjustments on farms other than the eight which reflected substantial changes in hours labor per PMWU, took the form of increase or decrease in off-farm work by the operator as hired or family labor increased or decreased. Other changes involved exchange labor or shifts in the time distribution of available labor. Usually compensations of various kinds prevented these farms from showing great changes in labor/PMWU. Total labor adjustments numbered 8 on 7 farms in 1957, 12 on 11 farms in 1958, and 5 significant changes by as many operators in 1959.

Adjustments in Machinery Use

Machinery inventory values as of January 1 of 1956 through 1959 were $5324, $4770, $4543, and $3955, respectively. When divided by the average of 128 acres of cropland per farm, the machine investment per crop acre was computed as $41.67, $37.33, $35.56, and $30.95 for the four consecutive years of the project period.

The authors synthesized an inventory of machinery sufficient to adequately meet the requirements of these 160-acre farms. New value of this hypothetical set of machinery totaled $17,143. Assuming a weighted life of 11 years, an ending salvage value of 5 percent of original cost, and a depreciation rate of 24 percent of remaining annual value, the mid-life, or 6 year inventory value of the machinery amounted to $3304. The mid-life depreciated value of the machinery actually on the sample farms during the 1956-59 period was $4648. The 4-year mean actual investment per crop acre of $36.31 was about $10 more than the $25.85 per crop acre investment associated with the synthesized inventory. In 1959 for example, 14 operators exceeded $25.85 investment per crop acre. This suggested that some operators had higher machinery investments than they needed and that some cost reduction

TABLE 11.—Adjustments in Labor Use and Requirements on 8 Labor Adjusting Farms, by Years.

Item		Farm Designation A	B	C	D	E[1]	F	G	E[1]
		Adjustment Made in Year							
		1957	1957	1957	1957	1957	1958	1958	1959
Year Prior to Adjustment:									
No. of PMWU's		368	347	249	148	80	464	176	36
Hrs. Labor Per PMWU		14.9	4.1	18.2	20.7	6.5	8.9	24.5	33.9
Year of Adjustment:									
No. of PMWU's		456	320	309	120	35	222	190	120
Hrs. Labor Per PMWU		9.6	13.0	10.4	31.2	37.1	22.5	14.7	16.3
Adjustment Made:									
Increase Hired Labor	(Hrs)	—200[2]	88	60				—1267	116
Increase Family Labor	(Hrs)	—900	550	— 225	200		900		370
Increase Operator Labor	(Hrs)		2300	—1125	450	750		— 250	225
Decrease Off-Farm Work			X	—X		X			X
Increase Soil Bank	(Acres)		24			32			—43
Increase Corn Acreage	(Acres)		—20			—30			97
Increase Hogs	(Sows)				—10				
Increase Dairy	(Cows)	12		5			—19		
Increase Beef	(Head)					—12			
Increase Poultry	(Hens)								200

[1]Same farm but occurring in 2 different years. Treated the same as if it were 2 different farms.

[2]Negative values in this section indicate a reverse direction. For example, —200 increase in hired labor means a decrease of 200 hours in hired labor.

TABLE 12.—Numbers of Major Machines on 25-Sub-Sample Farms at Beginning of 1956 and 1960.

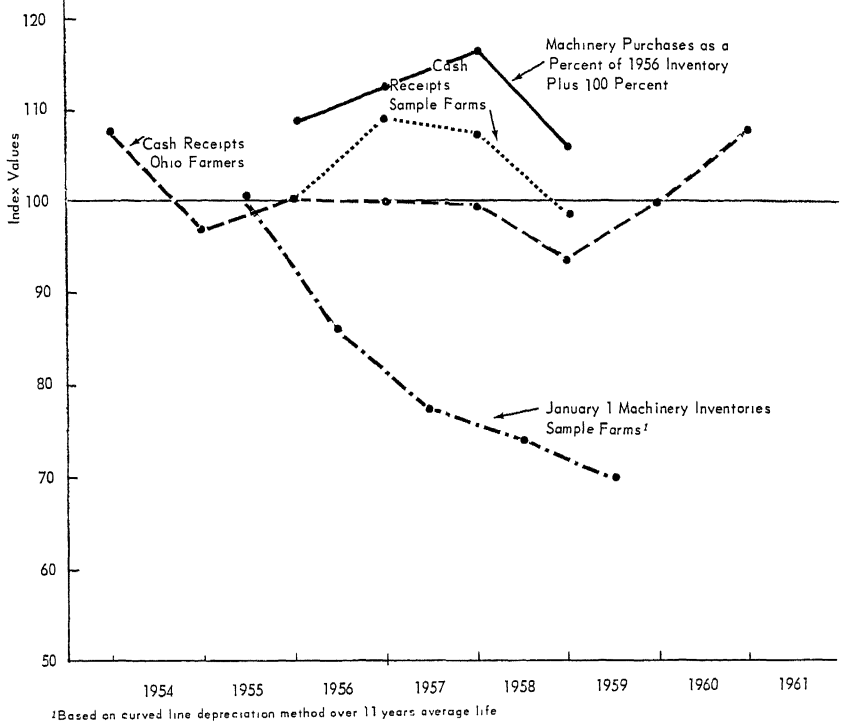
Kind of Machine	Size Rating	January 1 1956	January 1 1960
Tractors - Gasoline	All	50	56
Gasoline	1 bot.	4	6
Gasoline	2 bot.	35	38
Gasoline	3 bot.	11	11
Diesel	3 bot.	0	1
Baler	1 man	7	11
Combine - Pull type	5 - 8 feet	19	18
Self-propelled	8 - 10 feet	1	1
Corn Picker - Pull type	1 row	11	11
Pull type	2 row	6	4
Mounted	2 row	2	2
Picker-sheller		0	1
Field Chopper		1	3
Corn Planters	2 row	22	21
	4 row	3	4
Sprayer	6 row	9	13
Trucks	1 - 2 ton	5	7
Pick-up	½ - ¾ ton	8	10
Hay Crusher		0	1

might be achieved through machinery adjustment. Actual machinery investment per crop acre ranged from $9.13 on one farm to a high of $89.50 on another farm.

Numbers of major machines on the sample farms at the beginning and end of the 1956-1959 period are shown in Table 12. Some changes can be noted in the Table. Numbers of tractors, balers, field choppers, sprayers, trucks, and pick-ups increased. Changes in types of machines occurred in the addition of 1 diesel tractor, a picker-sheller, a 4-row corn planter, and a hay crusher.

The sample farmers tended to buy more machinery during the years in which their cash receipts were highest. This can be seen in Figure 3 where machinery purchases are shown as a percentage of the 1956 inventory, plus 100 percent. January 1 machinery inventories, cash receipts of the sample farmers, and cash receipts of all Ohio farmers are also shown in index form, with 1956 used as the base of 100. The operators cooperating in this study received relatively more cash receipts during the 1956-1959 period than the average of all Ohio farmers.

Fig. 3 –Indexes of Changes in Labeled Items, 1954-1961



[1]Based on curved line depreciation method over 11 years average life

A considerable amount of custom work was hired by the operators, primarily in harvesting operations. The sample farmers who owned harvesting machines also performed off-farm custom machine work for others in addition to work which they did on their own farms. Table 13 shows the amounts of custom machine work "in" and "out" on the sample farms, by years and by type of custom machine. No particular adjustment pattern is discernable other than an increase in custom combining and a decrease in hired spraying as four operators purchased their own sprayer. It can be seen in Table 13 that annual amount spent for custom machines tended to vary in the same direction as cash receipts from farming.

Several operators did off-farm custom machine work to increase acreage volume and thus lower per-acre machine investment cost. Many other major machine owners had too small an acreage-use to justify ownership of the machine as compared to costs of hiring custom

TABLE 13.—Use of Major Harvesting Machines, Custom Hired and Off-Farm by Operators, by Years, on 25 Sub-Sample Farms.

		1956		1957		1958		1959	
		Number Farms		Number Farms		Number Farms		Number Farms	
Combining									
on own farm	acres	20	960	20	869	19	800	19	868
for others	acres	5	153	5	70	4	205	7	114
custom hired	acres	6	60	7	178	6	184	7	190
Baling									
on own farm	acres	8[1]	224	8	326	8	338	11	544
for others	acres	3	316	3	189	5	146	6	247
custom hired	acres	13	283	13	361	10	298	8	299
Corn Picking									
on own farm	acres	20[1]	1043	19	895	19	873	20	1051
for others	acres	2	52	7	155	4	67	4	135
custom hired	acres	6[2]	112	7	94	7	172	8	131
Spraying									
on own farm	acres	9	—[3]		—[3]		—[3]	13	—[3]
for others	dollars	3	355	1	150	1	50	1	52
custom hired	dollars	4	220	2	50	1	25	1	50
Silo Filling									
on own farm	acres	1	10	2	6	3	39	3	29
for others	dollars			1	125			1	65
custom hired	dollars			6	759	5	630	4	423
Other Custom									
for others	dollars	1	400	2	524	2	1002	1	449
hired	dollars	1	343	1	125	1	436	2	285
Total Receipts from Custom Work		$3520		$2800		$3014		$2939	
Total Cost of Custom Machines		$4381		$5335		$5388		$3644	
Index of Cash Farm Receipts		100		109		107		98	

[1]Includes 1 machine owned by operator's father, rather than by operator, used on this farm on an exchange basis.
[2]Some operators with pull-type pickers hire a custom mounted picker to open corn fields.
[3]This information was not obtained from the operators

machines.[7] The ownership-custom pattern of these farmers shows that some do adjust acreage volume to lower their costs, but other operators still should consider very seriously the possibilitily of lowering costs through substitution between custom and owned machines, or by performing additional custom work for other farmers.

All machinery adjustments on the sample farms were counted. A total of 30 significant changes were noted with 8, 11, and 5 operators making changes in 1957, 1958, and 1959, respectively. These adjustments were primarily the purchase or sale of major machines other than for replacement, and substantial changes in amounts of custom work done off-farm by the operator or on-farm hired by the operator. A replacement for a higher level of technology, such as trading a 1-row pull-type corn picker for a picker-sheller, is considered a technological rather than machinery adjustment.

Adjustments in Technology

Many operators made significant changes in methods of production by adopting some new technique or machine which the operator had not previously used. Other operators substantially increased or decreased use of some input, such as fertilizer for example, as compared with previous pattern of use. Still other operators changed to new varieties of seed.[8]

Perhaps the best method of presentation of technological adjustments is to simply list them, with the number of sample operators adopting each innovation during the 1956-1959 period: Eight operators significantly changed amount of fertilizer used; one operator adopted use of fertilizer; one operator changed to liquid form of fertilizer (installed 1000 gallon tank); three farmers installed a bulk tank for the dairy enterprise; two operators added a pipeline milking system; one changed from stanchion to side opening parlor milking system; one dairy operator initiated artifical insemination; one cooperator installed an egg washer and cooler system; one operator who had not previously baled hay, purchased a baler; one farmer adopted a hay crushing system; a diesel tractor supplanted a conventional type on one farm; one operator began spraying corn for the first time; one pull-type corn-picker was replaced by a picker-sheller; another pull-type picker and a grain combine were traded for a self-propelled combine with

[7]More detailed analysis of this will be given in, "Economic Evaluation of Machinery Investment on 160-Acre Farms in Western Ohio" by J. R. Tompkin and E. T. Steiner, to be published cooperatively as a bulletin by the Ohio Agricultural Experiment Station and Economic Research Service.

[8]Unfortunately, the operators were not questioned as to the variety of seed they used, so that particular type of innovation is not included in technological adjustments.

corn-picker head; and one operator changed from 2-row to 4-row corn planter and cultivator.

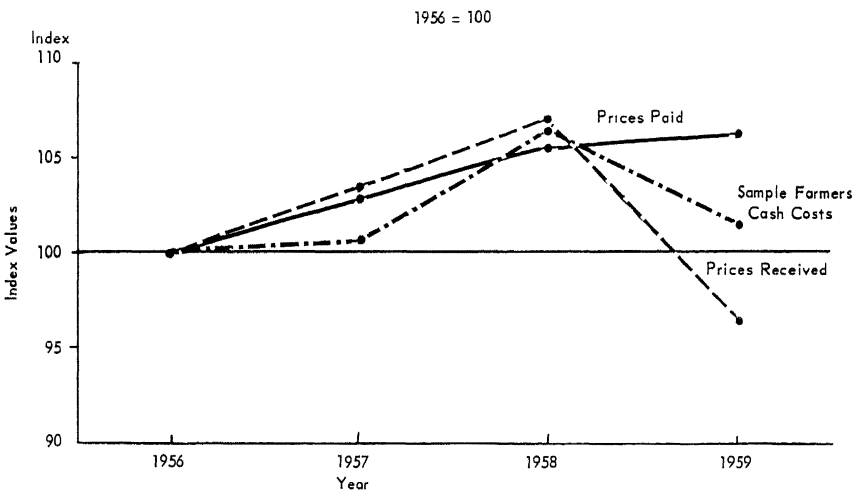
In all, 25 adjustments classified here as technological in nature, were made by 17 farmers. Three operators recorded two shifts each while two other cooperators made 3 and 4 adjustments, respectively. Undoubtedly other significant technological changes were made by these sample farmers during the period, but not recorded. It is interesting to note that 11 of the 25 adjustments were concerned with machinery or equipment.

Adjustments in Cash Costs

The operators annual total cash costs were recorded and plotted in index form (1956 = 100) in Figure 4. The index of prices paid by farmers[9] for production items was converted to a 1956 = 100 base and inserted into Figure 4. The Ohio Index of Prices Received by Farmers is also shown. It can be seen that the index of prices paid continued to rise after 1958, whereas prices received declined. This caused many operators to make substantial reduction in costs in 1959. The average cash costs per farm in the study were $5465, $5504, $5828, and $5557 for 1956 through 1959, respectively. Hog farms ranged from $6123 in 1957 to $6317 in 1958 and had the highest cost per farm

[9]Taken from 1962 Agricultural Statistics, USDA. The U.S. figures were used because an Ohio index was not available.

Fig. 4.—U.S. Index of Prices Paid, Ohio Index of Prices Received, and Sample Farmers Cash Costs, 160-Acre Farms, 1956-1959



of any farm type studied in each of the four years. Dairy farms were second each year with average total cash costs of $5286, $5533, $6234, and $5672 for 1956 through 1959. Cash grain farms and general livestock units averaged $3986 and $4804 per year, respectively.

Total cash costs were divided into 12 categories, and each farm was examined each year from 1957 through 1959 to determine the number of significant departures from the normal pattern in each classification. A significant increase or decrease in a given year constituted a cost adjustment for that farm. In 1957 twelve operators made a total of 14 adjustments. The following year 17 farmers made 23 different adjustments and in 1959 twelve farms showed 13 significant changes from their normal cost patterns. Thus, of 12 classes for three years for 25 farmers, there were 50 adjustments made of the 900 possible, or between five and six percent.

Adjustments in Improvements

This group of adjustments includes major additions to buildings, new buildings, and unusually large expenditures on land improvements. In all, 13 adjustments were made during 1957-1959. They are: Addition of a chicken house; construction of new silos on 3 farms; complete renovation of a barn; erection of major pole-type structures on 2 farms; purchase of a large wire-metal corn crib; installation of two major tiling projects; conversion of existing buildings to butchering area for commercial home butchering; substantial expansion of commercial butchering facilities on 1 farm· and building of one new barn.

Adjustments and Type of Farm

The sample farms were arrayed according to number of adjustments made per farm during 1957-1959, with the largest number of shifts at the top and descending to the least number of changes at the bottom. The range was from 24 to 1 with a mean of 11.2. Dairy farms averaged 12.44 and hog farms 9.50 per farm, with general livestock and cash grain farms nearer the mean. By use of group comparison methods, the dairy and the hog farms were tested against the entire group mean. The "t" values were not significant. The conclusion must be that the number of adjustments does not differ greatly by farm type.

The distribution of adjustments was tested for normality. One and two standard deviations on either side of the mean contained 72 percent and 96 percent, respectively, of the observations. Comparing this with the standard 68 27 and 95.45 percent, the numbers of adjustments are quite normally distributed.

Relationship of Actual Adjustments to Income

A multiple correlation was used to determine the association with income of the various types of adjustments made by the sample farmers. Returns to owned capital, management, and unpaid labor was used as the dependent variate. The values of the significant changes making up the previously mentioned types of adjustment comprised the independent variables.

Livestock adjustments correlated with the dependent variable at the .01 probability level, with spring litter adjustments showing the highest relationship. Significant changes in fall sow farrowings was second with adjustments in other livestock enterprises having no statistically significant affect on family income.

Machinery adjustment correlated with income at the .05 probability level and improvements adjustments were associated with income at the 7 percent level. Capital adjustments in the form of substantial long and short term debt changes were associated with income at the 11 and 16 percent level, respectively.

Cost, technological, cropping, and labor adjustments showed no important relationships with the family income actually received by the sample farmers.

FACTORS RELATED TO ADJUSTMENT

Influences on Types of Adjustment

This section reports an attempt to isolate the factors which influenced the kind and extent of adjustments made by the sample farmers. A number of possible influencing factors were tested by means of correlation procedures to determine associations between factors and adjustments.

The factors considered were made independent variables ($X_{1 \ldots 25}$) and the previously discussed types of adjustments were the dependent variates ($Y_{1 \ldots 9}$). The 25 independent variables used were: X_1 - number of crop acres per farm; X_2 - amount of labor in most restricted month; X_3 - annual amount of unpaid labor; X_4 - amount of capital available; X_5 - operator's percent equity in business; X_6 - net worth of operator; X_7 - number animal units of livestock· X_8 - number price map areas per farm; X_9 - normal selling-month price of fat hogs in fall this year minus last year· X_{10} - previous year normal selling-month price of fat hogs in fall minus 2 years ago; X_{11} - normal selling-month price of fat hogs in spring minus last year; X_{12} - previous year normal selling-month price of fat hogs in spring minus 2 years ago; X_{13} - normal selling-

month price of fat cattle minus last year; X_{14} - last year's normal month selling price of fat cattle minus 2 years ago; X_{15} - 2 years ago normal month selling price of fat cattle minus 3 years ago; X_{16} - cost of fertilizer and lime used; X_{17} - current year's average price of milk/cwt. minus last year's price; X_{18} - last year's average price of milk/cwt. minus average price 2 years ago; X_{19} - corn price received at major selling time this year minus price at that time last year (If none were sold, closing inventory values were used); X_{20} - previous year's labor income; X_{21} - previous year's cash costs/PMWU; X_{22} - age of operator; X_{23} - education of operator; X_{24} - amount of reinvestment, over annual commitment, in business; and X_{25} - current year's cash costs.

The results of the correlation are shown in Table 14. The 25 independent variables are arranged on the left margin and the dependent variates across the top of the table. The simple correlation coefficients, with significance level designated, are placed in their appropriate cells.

Supplemental correlations were also run involving the associations between the various types of adjustment (Y_1 through Y_9). Every special type of adjustment was highly correlated with total adjustments but this, of course, is to be expected inasmuch as Y_9 is the sum of Y_1 through Y_8. More important are the associations between Y_1 through Y_8. The correlations are shown in Table 15.

In the following discussion of associations identified with each type of adjustment, continuous reference to Tables 14 and 15 will be helpful to the reader.

Total adjustments are significantly influenced by the amount of capital an operator possesses, by the degree to which he reinvests that part of his income exceeding his committed expenditures, and by the amount of current cash costs he incurs.

The independent variables affecting **crop adjustments** are the percent equity the operator has in his total investment, the size of his net worth, and his cost efficiency of the previous year. This suggests that the operator in the best risk bearing position because of greater asset accumulation and relatively fewer liabilities will tend to make more adjustments in his cropping pattern. This may, of course, be reversible in that the operator who is more prone to make needed adjustments acquires a greater equity and net worth than those operators who do not make changes.

Livestock adjustments are made more often by those operators with greater amounts of capital and a better net worth position. When

TABLE 14.—Correlations of 25 Independent Variables With Adjustment Types, 1957-59.

Independent Variables	Dependent Variables[1]								
	Y_1	Y_2	Y_3	Y_4	Y_5	Y_6	Y_7	Y_8	Y_9
Number of Crop Acres	.14	.04	—.06	.20†	.08	—.05	.20†	.09	.18
Hours of Labor in Most Restrictive Month	—.13	.14	—.06	.13	.13	.07	.07	.14	.12
Hours of Unpaid Labor	—.08	.04	—.02	.22†	.16	12	.09	.08	.15
Capital Available	—.12	.33**	.14	.22†	.26*	.12	.25*	.14	.35**
Percent Equity	—.50**	.10	.08	—.14	.11	—.02	.05	—.16	—.22†
Net Worth	—.34**	.30**	.16	.04	.26*	.04	.21†	—.12	.11
Animal Units of Livestock	—.08	.14	.05	.16	.06	.17	—.03	.09	.15
Number of Price Map Areas	.03	.00	.06	.06	.10	.08	.17	.02	.13
Fall Hog Price, This-Last	.02	—.26*	.09	.13	.19	.12	.06	.02	.05
Fall Hog Price, Last-2 Years Ago	—.21†	—.07	—.01	.03	.12	.14	—.10	.12	—.05
Spring Hog Price, This-Last	.01	—.05	.17	.03	.18	—.10	—.04	.04	.05
Spring Hog Price, Last-2 Years Ago	—.09	—.01	.05	—.01	.13	.03	—.11	—.03	—.02
Fat Cattle Price, This-Last	—.15	.07	.28*	.14	.28*	.08	—.09	—.08	.12
Fat Cattle Price, Last-2 Years Ago	—.05	.04	.01	—.02	.09	.08	—.03	—.03	.03
Fat Cattle Price, 2 Years-3 Years Ago	.07	.04	—.21†	—.15	—.34**	—.13	.02	.10	—.14
Cost of Fertilizer and Lime	—.04	.07	.08	.09	.23†	.21†	.30**	.26*	.28*
Milk Price, This-Last	—.10	.07	—.04	—.13	—.10	—.21†	—.07	.04	—.16
Milk Price, Last-2 Years Ago	.01	.08	—.05	—.32**	—.23*	.17	—.20†	—.07	—.12
Corn Price, This-Last	—.05	—.21†	.14	—.10	.13	—.04	—.08	.11	—.09
Last Year's Labor Income	—.09	.21†	—.05	.06	.10	—.10	.08	.07	.08
Last Year's Cash Costs Per PMWU	.26*	.01	—.03	—.01	—.02	—.09	—.04	.15	.11
Age of Operator	.00	.26*	.05	—.23*	.00	.07	—.18	—.04	.04
Education of Operator	.14	—.27*	—.20†	—.09	—.09	.08	—.10	.02	—.13
Amount of Reinvestment Over Annual Commitment	.07	—.18	.39**	.33**	.39**	—.01	.35**	.25*	.35**
Current Year's Cash Costs	—.01	.06	.13	.22†	.28*	.20†	.14	.43**	.35**
$R =$	.765**	.688*	.614	.625	.689*	.601	.703*	.606	.724*
$R^2 =$	.586	.474	.376	.391	.474	.361	.494	.367	.525

[1]Identification of the dependent variables (Y_1 through Y_9) is shown in Table 15.

*Significant at .05 level of probability.

**Significant at .01 level of probability

†Significant at .10 level of probability.

TABLE 15.—Correlations Between Types of Adjustments, 1957-59.

Types of Adjustment	Y_2	Y_3	Y_4	Y_5	Y_6	Y_7	Y_8	Y_9
	(r)	(r)	(r)	(r)	(r)	(r)	(r)	(r)
Cropping (Y_1)	—.15	.07	.21†	—.14	—.10	.00	.02	.42**
Livestock (Y_2)		.06	.05	—.06	.03	.01	.00	.38**
Labor (Y_3)			.21†	30**	.05	.27*	.22†	.52**
Machinery (Y_4)				33**	.08	.24*	.09	.60**
Technological (Y_5)					.19	.20	.16	.44**
Cost (Y_6)						.10	.12	.38**
Improvements (Y_7)							.06	.41**
Capital Use (Y_8)								.31**
Total (Y_9)	.38**	.52**	.60**	.44**	.38**	.41**	.31**	

*Significant at .05 level of probability.
**Significant at .01 level of probability.
†Significant at .10 level of probability.

the previous year's labor income was high, the operator was more likely to make adjustments in his livestock. Another logical relationship appearing at the .10 level of significance is that livestock adjustments are less likely when the current corn price is higher than the corn price of the previous year. The age of the operator is associated positively with livestock adjustment but the higher the operator's education the less likely he is to adjust his livestock enterprises.

Labor adjustments show up as being dependent on the amount of reinvestment the operator makes with those funds over and above that needed for family living expenses and annual debt repayment commitments. Two other significant correlations suggest that a rise in price of cattle over a 3-year period stimulates labor adjustments.

The younger operators and those with a more vigorous policy of income reinvestment show a greater tendency to make **machinery adjustments.** At the 10 percent probability level are found such positive influences on machinery adjustment as the number of crop acres in the farm, the amount of capital the operator has available, how large his current cash costs are, the amount of crop adjustments he has made, and the amount of labor he has available.

Technological adjustments are more likely to be made by those operators with a better capital and net worth position than by those operators whose financial and risk bearing position are more precarious. High current cash costs seem to go hand in hand with more technological adjustment. This is probably because the costs of some of these

kinds of adjustments are frequently included in the current total cash costs of the farm. Fertilizer and lime adjustments are examples of this. A complex of hog and cattle prices are associated with an increase or decrease in technological adjustments. Interpretation of these suggests that during the first year or so of an upward trend of livestock prices the operator is less likely to make technological changes than if the upward price trend continues into the third consecutive year. Labor and machinery adjustments and reinvestments of funds into the farm business either stimulate technological adjustments, or else an operator who makes labor and machinery changes with fund reinvestment also is the type who will make technological changes as well. Perhaps one kind of change necessitates, or makes easier, another type of adjustment.

Cost adjustments do not seem to be related very strongly to any independent variables included in this correlation problem. The level of current cash costs and the extent of technological change made by the operator each show a positive relationship with cost adjustments at the .10 probability level.

The likelihood of operators making **improvements adjustments** depends somewhat on capital available, cost of such major improvements as substantial fertilizer and lime increases, amount of annual reinvestment the owner chooses to make, and the number of labor and machinery adjustments he has made or will make during the year. To a lesser extent, adjustments in improvements are influenced by the number of crop acres in the farm, the technological adjustments made, and the net worth position of the operator. These last three factors each show relationship to the dependent variate at the .10 level of probability. An increase in milk prices in the previous 2 years was inversely associated with improvements adjustments. This was significant at the 10 percent level of probability. The reader will recall that in the discussion of technological adjustments it was stated that during the first two years of an upward trend of livestock prices, the operator was less likely to make adjustments than if the price rise continued into the third consecutive year. For this explanation to also be valid in explaining the present milk price-improvements adjustment relationship, dairy farms would have to exert major import on the relationship. Checking the original data, it was found that eight of the thirteen improvements adjustments were in fact made by dairy farmers. Thus the inverse relationship seems logical.

Capital adjustments were associated with the current year's cash costs and the reinvestment policy of the operator. Again, reversibility

is logical, that is, the greater the capital adjustments made by the operator, the greater will be the cash costs and the larger the reinvestment of funds into the farm business. Higher costs of fertilizer and lime applications are also associated with more capital adjustments but this is more likely because this type of cost is a major ingredient in total current cash costs. The positive relationship of number of labor adjustments with the number of capital adjustments is significant at the .10 probability level and suggests a possible adjustment required in the management of one of the two resources when the other production factor has been altered.

A correlation was run to determine the effect of household demands on reinvestment of disposable income in the farm business. Mean farm reinvestment correlated highly with mean disposable income[10] ($r = .60$, $df = 23$) with each $1 of disposable income being associated with $.27 reinvestment in the farm business. This regression coefficient tested significant at the .01 level ($t = 2.955$, $df = 23$). Farm reinvestment showed no real relationship with household demand for funds expressed in terms of value of household conveniences. This suggests no particular current conflict between firm and household for available funds.

Effect of Non-Economic Factors on Number of Adjustments

During the last interview in the spring of 1960 the sample operators were asked whether or not their decisions were influenced by certain non-economic factors to the extent that a probably more profitable alternative was rejected. Of some dozen items in the list, four were found to influence operator decision-making more than the others. These four were: (1) personal preference of the operator, (2) operator's aversion to borrowing money (even if funds are available and could be borrowed), (3) competition of the household for funds available for investment in the farm business, and (4) reluctance of the operator to give up part of his existing leisure time.

The operators who answered "no" to each question were placed in one group and those who replied "yes" were included in a second group. Group comparison techniques were used to test homogeneity of the two groups with respect to numbers of adjustments made by the operators during the 1957-1959 period. Results were tested for statistical significance by the "t" test.

Eleven of the 24 operators from which answers were received replied "no" on the influence of "reluctance to give up leisure time".

[10]Mean disposable income was computed by adding all receipts and inventory increases to increase in total debt and substracting inventory decrease, cash operating expenses, and committed debt payment.

These 11 made 128 adjustments during 1957-1959 while the 13 "yes" farmers made 136. The "t" value of .486 was not significant even at the .10 probability level.

Results were obtained for the comparisons of the "yes" and "no" groups for the other three questions. On each of the four questions the "no" group averaged from 1 to 1.5 more adjustments per operator than the "yes" group, but none of these differences were statistically significant. The conclusion must be that these non-economic factors which over 50 percent of the operators agreed influenced their decision, did not materially influence shifts important enough to be considered as adjustments, but rather served as stabilizers to lessen adjustment.

Estimating Equation for Number of Adjustments

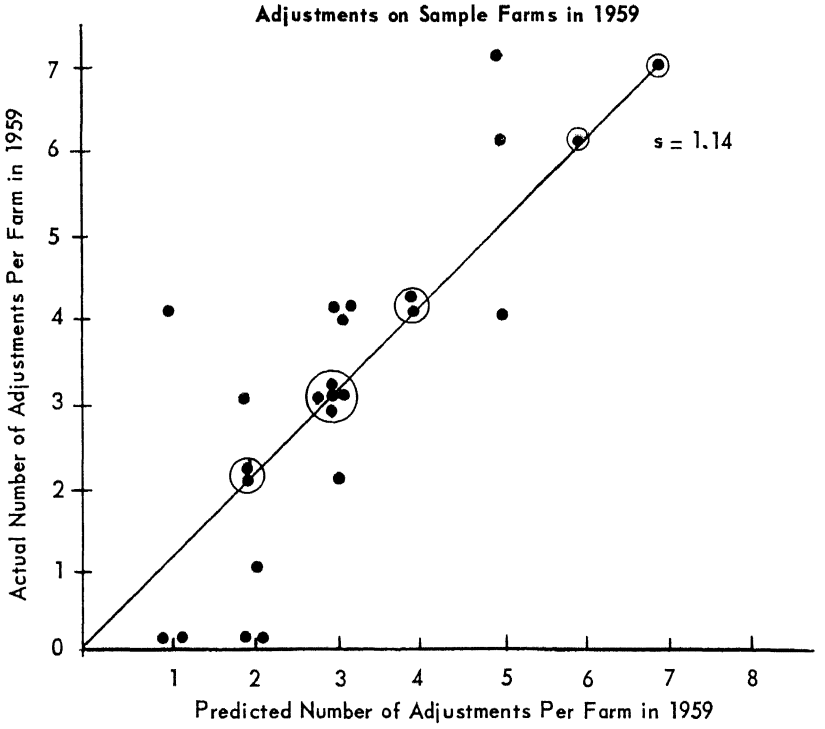
With the information obtained from the previously discussed correlations, a linear regression model containing seven independent variables and one dependent variate was used to derive a regression equation suitable for predicting the number of adjustments a given farmer would be expected to make during the coming production year. The variables used were: Y - number of adjustments expected during the coming calendar year; X_1 - disposable income expected during the coming calendar year with the operator's actual farm organization and assuming no cost for possible adjustments; X_2 - previous year's expenditure for fertilizer and lime; X_3 - amount of capital available; X_4 - percent of operator's equity in the farm business; X_5 - previous year's cash costs; X_6 - number of adjustments made 2 years ago; and X_7 - number of adjustments made last year.

The multiple correlation coefficient (R) of .789 tested statistically significant at the .01 probability level. The coefficient of multiple determination (R^2) of .623 indicated that more than 60 percent of the variation in the dependent variable was associated with the independent variates used. The derived regression equation was:

$$Y_E = 6.41673 - .00013X_1 + .00093X_2 + .23416X_3 - .05982X_4 - .00037X_5 + .27122X_6 + .02692X_7.$$

The equation was applied to each of the 25 sub-sample farms to estimate the number of adjustments expected to be made during 1959. Inasmuch as the actual adjustments in 1959 were known, a check could be made on the accuracy of the estimates. The results are shown in Figure 5 where the actual number of adjustments made on each farm in 1959 are plotted against the predicted number. A line of 45 degrees slope is drawn from the origin. If actual and predicted numbers coincide, the point will fall on the 45 degree line. It can be seen that the

Fig. 5.–Comparison of Actual and Predicted Number of Adjustments on Sample Farms in 1959



scatter diagram fits rather well around the line with the exception of four farms. Eleven farms were estimated exactly when the predicted values were rounded to the nearest whole adjustment.

The authors recognize that this procedure gives equal weight to an adjustment of 20 acres of corn, for example, and an adjustment of such magnitude as erection of a new barn. The same procedure can be applied, however, within each type of adjustment where the adjustment sizes are much more homogeneous. Further study should be undertaken to develop a method of weighting or scaling the various adjustments in terms of effect on farm income.

DESIRABLE ADJUSTMENTS AS INDICATED BY PROGRAMMING OF SAMPLE FARMS

Variable-Price Linear Programming[11]

Each sample 160-acre farm was linear programmed, using a variable-pricing technique, to determine the optimum use of the opevator's production resources at various hog and beef price levels and with prices for crop products, milk, eggs, wool, and lamb held unchanged throughout all solutions.

Development of Programming Matrix

Restrictions to the problem were the amounts of production resources available on each sample farm. Alternative activities which could possibly be used by the operator to maximize returns were included. A 2-litter hog enterprise was used. A beef-feeder program was selected because the 160-acre farms were too small to sustain an economic unit of beef cows. The dairy system used was selected from the most appropriate of several compared in previous work[12] in this project. The production and cost coefficients used for each farm were taken from the four-year history of the farm as obtained in the annual enumeration of the sample operators from 1956 through 1959. This was done to include in each program matrix those coefficients consistent with the management ability level of the particular operator. Feeding practices were synthesized as typical.

Prices of products used in the matrix are shown in Table 16. No Grade B dairy enterprise was allowed in the matrix inasmuch as previous computations indicated it could not come into the final solution. Investment values of dairy cows were fixed according to amount of milk production. Hogs were sold at weights between 190-230 pounds, according to the practice of the individual operator. In the beef-feeding alternative, feeder calves were bought at 400 pounds and sold as fat cattle at 900 pounds. Costs were adapted to the individual operator in the light of his cost history. Fixed costs were not included in the matrix but were added later on the worksheets in deriving net family labor earnings. The land resource for each farm was, of course, fixed. Labor included operator and family labor plus up to 100 hours per month hired labor as needed in the peak labor months. Capital was derived as value of feed and livestock inventories plus cash on hand

[11]The concept of linear programming is simply the derivation of the optimum allocation of existing resources among alternative activities, when costs and returns are known. In this study, the optimum allocation was taken to be that which gave maximum income.

[12]"Optimum Combinations of Resources for Dairy Farms in West Central Ohio" by Westcott, E. R., unpublished Ph. D. dissertation. Ohio State University, Columbus, Ohio, 1959.

TABLE 16.—Prices Used in Linear Programming Model.

Commodity	Unit	Purchase Price	Sale Price
		Dollars	Dollars
Milk, Bulk Cooled	cwt.		3.95 (net)
Milk, Can Cooled	cwt.		3.80 (net)
Wool	pound		.58
Lamb	pound		.20
Eggs	dozen		.33
Hens	pound		.12
Chicks	chick	.30	
Corn	bushel	1.22	1.15
Oats	bushel	.72	.64
Hay	ton	21.00	20.00
Wheat	bushel		2.00
Fat Hogs	cwt.		13.00 - 32.00[1]
Fat Beef	cwt.		14.00 - 40.00[1]

[1]In the variable pricing procedure used these are the ranges within which prices of hogs and beef cattle were permitted to vary. Price ranging went higher on some farms than on others; thus, the ranges shown represent the lowest price used on any farm and the highest price used on any farm.

plus reasonable expectation of receipts, less $2000 annual living expenses less committed interest and debt repayment. The reasoning here was that farmers reinvest excess receipts during the year, so beginning capital included "borrowing" against disposable income.

The finished matrix contained 17 rows of which 16 were resource availabilities and one was the CJ, or income row. The model contained 32 columns of which four were transfer columns and nine were disposal or slack vectors, used in those cases where no "sell" activity was used. One resource availability column, six buy and sell activities, and 12 crop and livestock alternatives made up the balance of the 32 columns. A "typical" year for the three-year period of 1957-1959 was programmed rather than to program each of the three years for each farm. The programming model is shown in Appendix A.

Programming Results: Price Mapping

The results of the programming were placed in a work form (shown in Appendix B) and family labor earnings were computed after inclusion of perquisites, fixed costs, and hired labor cost correction when hired labor allowed was not used.

The results of each programmed farm were price-mapped to show graphically the changes in optimal plans associated with the changing

hog and beef price relationships as other prices remained constant. A sample of a price-mapped farm is shown in Figure 6. On this particular farm, price was ranged from $17 to $21.50 for hogs and from $23 to $29 for beef. The graph shows 18 different price areas or organization plans. Table 17 shows the optimum organization for each section in the price map.

For example, the optimum enterprise combination in Plan 1 (where hogs vary up to $18.25 and beef price varies up to $23.66) would be 19 dairy cows, 40 acres of corn, 5 acres of oats, 3 acres of hay cut twice, 25 acres of hay cut one time, 13 acres of rotation pasture, 13 acres of permanent pasture, and 20 acres in Soil Bank. The operator will sell 2177 bushels of corn and must buy 135 bushels of oats and 35 tons of hay. As hog price went above $18.25 and beef stayed under $24.40, Plan 2 would optimize use of resources. The operator would produce 339 cwt. of hogs and cut his dairy herd to 13 cows. He would sell no corn and would buy more oats and less hay.

Within any one section of the price map the resource combination remains the same. Adjustment to changing price relationships may move the farm organization across an area boundary into another area, in which case resource re-allocation takes place and a new maximum income is obtained. The reader should be informed, however, that going from one price map area into another area might change income only a few dollars or it might substantially affect operator income. Study of the production included in each price map area shows which price area boundaries constitute enterprise dropout or add points as prices of those enterprise products increase or decrease.

A larger number of small price map areas for a given farm indicates more resource flexibility, within the range of product prices considered, than does fewer but larger areas. As a greater proportion of a total resource fund is restricted to a specialized enterprise, a smaller proportion is available to other substitute activities. As this resource rationing increases, the cost of factors to the non-specialized use becomes higher. Inasmuch as this increased resource cost is reflected in the income row for the various activities in the matrix, a higher product price is necessary to bring the non-specialized alternative into the optimum solution. Thus, resource rigidity causes fewer, but larger, price map areas within a given range of product prices. One farm in the study, for example, was subject to such severe capital rationing that throughout the entire range of beef prices the operator was forced to cash grain farming despite the fact that the land was more suited to livestock. Only when hogs reached a price of $23.75 was livestock

Fig. 6.—Sample Price Map for an Individual Farm

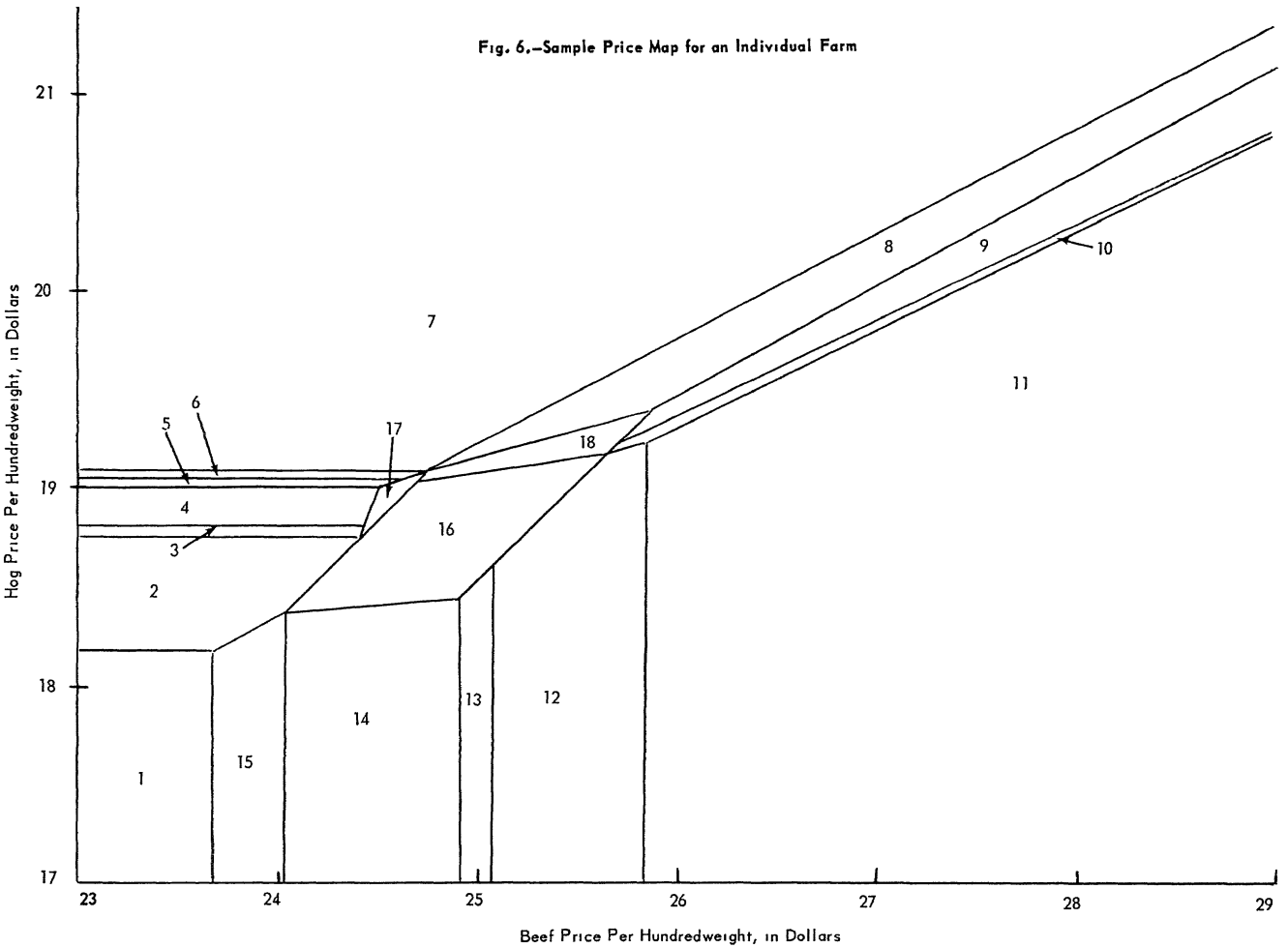


TABLE 17.—Optimum Organizations for Price Map Areas on an Actual 160-Acre Sample Farm, with Actual Farm Organizations for 1957-59.

Resource Use Alternatives	Price Map Area Number										
	1	2	3	4	5	6	7	8	9	10	11
Beef Feeders (Cwt)	0	0	0	0	0	0	0	107	182	298	367
Hogs (Cwt)	0	339	366	377	518	697	729	528	389	142	0
Dairy (Cow)	19	13	12	12	8	1	0	0	0	0	0
Sheep (Ewe)	0	0	0	0	0	0	0	0	0	0	0
Poultry (Hen)	0	0	0	0	0	0	0	0	0	0	0
Corn (Acre)	40	40	40	43	56	60	60	60	60	48	42
Oats (Acre)	5	5	5	5	5	5	5	5	5	5	5
Two Cuttings Hay (Acre)	3	5	5	5	8	15	16	22	29	40	40
One Cutting Hay (Acre)	25	24	24	24	23	20	20	18	11	0	0
Rotation Pasture (Acre)	13	11	11	11	9	5	4	0	0	0	0
Permanent Pasture (Acre)	13	13	13	13	13	13	13	13	13	13	13
Soil Bank (Acre)	20	20	20	17	4	0	0	0	0	12	18
Buy Corn (Bu)	0	0	164	0	0	759	948	386	0	0	0
Sell Corn (Bu)	2177	0	0	0	0	0	0	0	0	0	0
Buy Oats (Bu)	135	742	785	807	1034	1301	1347	1018	791	371	132
Sell Oats (Bu)	0	0	0	0	0	0	0	0	0	0	0
Buy Hay (Ton)	35	5	0	0	0	0	0	0	0	0	0
Sell Hay (Ton)	0	0	0	0	22	58	65	59	51	40	29
Variable Family Income[1]		$4518 (1957)									$6353 (1958) $5619 (1959)

[1]Maximum variable family income (fixed costs not yet deducted) in 1957 was $4518 and occurred in area 2 of the price map with the hog and beef price relationship as it was in 1957. Variable family income from the operator's actual 1957 organization was $4499. With hog and beef price relationships as they were in 1958 and 1959, maximum variable income occurred in price map area 11 for both years. The farmer's variable income for 1958 and 1959, with the resource allocation he actually used, was $5780 and $2507, respectively.

TABLE 17. (Continued)—Optimum Organizations for Price Map Areas on an Actual 160-Acre Sample Farm, with Actual Farm Organizations for 1957-59.

Resource Use Alternatives	Price Map Area Number							Actual Farm Organization		
	12	13	14	15	16	17	18	1957	1958	1959
Beef Feeders (Cwt)	345	324	210	183	191	31	135	0	0	0
Hogs (Cwt)	0	0	0	0	151	536	435	507	545	626
Dairy (Cow)	1	2	9	10	6	5	2	0	0	0
Sheep (Ewe)	0	0	0	0	0	0	0	0	0	0
Poultry (Hen)	0	0	0	0	0	0	0	0	0	0
Corn (Acre)	40	40	40	40	40	60	60	95	109	108
Oats (Acre)	5	5	5	5	5	5	5	0	0	0
Two Cuttings Hay (Acre)	40	40	22	20	22	13	22	0	0	0
One Cutting Hay (Acre)	0	0	18	19	18	21	18	0	0	0
Rotation Pasture (Acre)	0	0	0	2	0	6	0	10	9	10
Permanent Pasture (Acre)	7	13	13	13	13	13	13	13	13	13
Soil Bank (Acre)	20	20	20	20	20	0	0	0	0	0
Buy Corn (Bu)	0	0	0	0	0	0	0	0	0	1714
Sell Corn (Bu)	0	130	839	1001	0	0	0	1725	1050	1563
Buy Oats (Bu)	134	135	144	146	405	1057	874	200	0	0
Sell Oats (Bu)	0	0	0	0	0	0	0	0	0	0
Buy Hay (Ton)	0	0	0	0	0	0	0	0	0	0
Sell Hay (Ton)	28	27	7	0	20	34	40	0	0	0
Variable Family Income								$4499	$5780	$2507

profitable, and even then only three sows on a 2-litter system. That farm had only two very large price map areas. The distribution of number of price map areas per farm for all farms in the sample is shown in Figure 7.

Multiple Correlation with Number of Price Map Areas As Dependent Variable

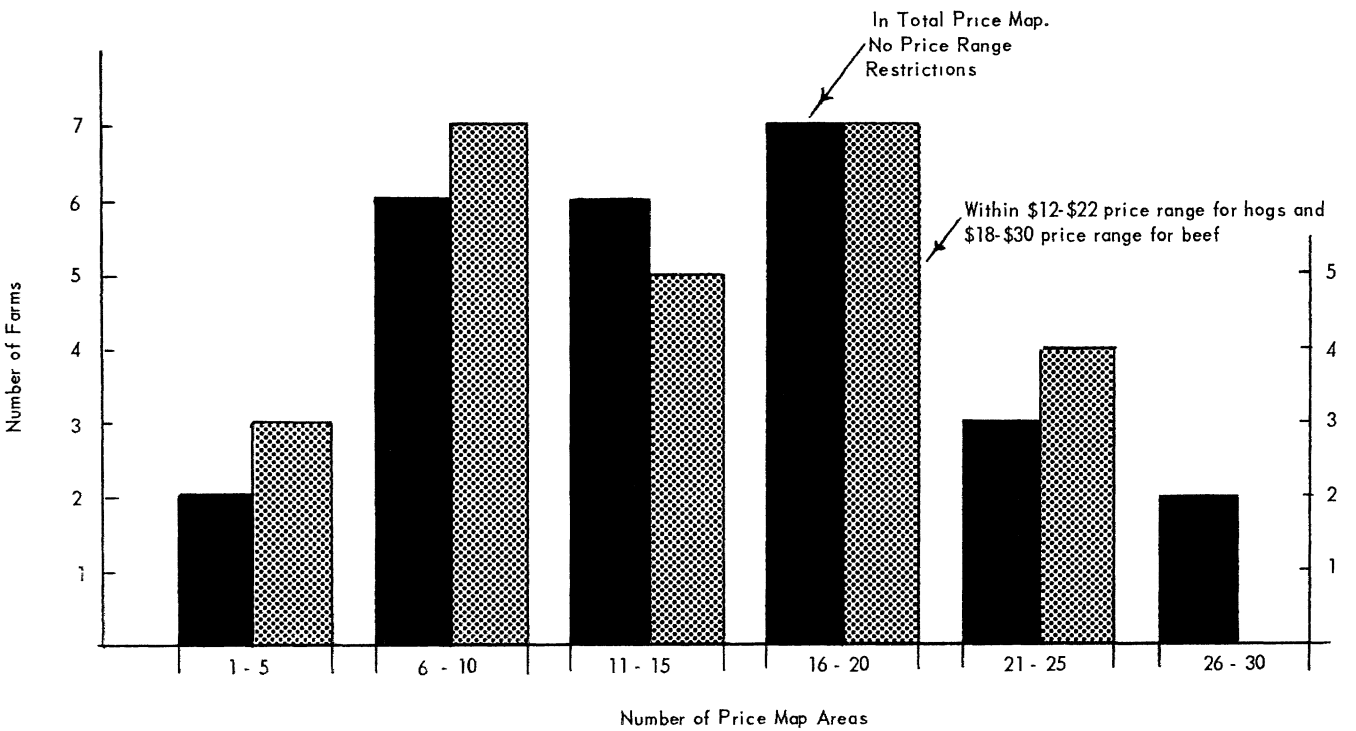
For a test of the hypothesis that number of price map areas can be used as a measure of resource flexibility, a 12-variable multiple correlation was run with number of price map areas as the dependent variate.[13] Several other factors used in other analyses and which appeared to be associated with income and with labor and cost efficiency, were used as independent variables. They were: X_1 - amount of capital available; X_2 - number of square feet of good housing; X_3 - cash operating costs per PMWU; X_4 - number of PMWU's per farm; X_5 - labor income; X_6 - cash operating cost; X_7 - farm efficiency index (based on output over input); X_8 - farm cost index; X_9 - corn CJ[14] values; X_{10} - poultry CJ value; and X_{11} - dairy CJ value. Hog and beef CJ values were not included in that they were variable according to hog-beef price relationships in the programming which produced the number of price map areas, and secondly, the correlation between hog and beef costs and the cost index (X_8) would be high on those farms where hogs and beef were important enterprises because they would be responsible for a large portion of the costs used in deriving the cost index. Actually, corn, poultry, and dairy CJ's occupy the same position but were readily available so they were used somewhat in a check capacity (they subsequently correlated at the .01 level with cost index).

The R and R^2 were .865 and .748, respectively, with $N = 25$. Number of price map areas correlated positively and significantly at the .01 level with amount of capital available and with the size and business volume of the farm as expressed in number of PMWU's. The dependent variate also correlated inversely at the 5 percent level with cash operating costs per PMWU and positively at the 12 percent level with the size of the net variable income per corn unit produced. Housing adequacy, labor income, cash operating costs, and the over-all efficiency index all correlated with number of price map areas at between the .15

[13]Because both size and number of price map areas appear to be functions of resource flexibility, the dependent variate in this multiple was the number of price map areas within the same given price range on the X and Y axes for every programmed farm. The practical working range was considered to be $12 to $22 per hundredweight for hogs and $18 to $30 per hundredweight for beef.

[14]A CJ value in a programming matrix is the net variable income per unit for the particular enterprise alternative to which it applies It can also be thought of as an opportunity cost to the next best enterprise alternative.

Fig. 7.–Distribution of Number of Price Map Areas Per Farm, in Total Map, and within Specified Range of Hog and Beef Prices



to .19 probability levels. These results strongly suggest that number of price map areas within a given range on the X and Y axes of the price map can be used as indicators of relative resource flexibility within the specified range of product prices.

Actual and Programmed Organization Differences on Individual Farms

The individual optimum solutions were compared with the actual farm organizations for each year of the 1957-1959 period. Both resource combinations used the actual beef and hog prices received that year by the operator. Prices of other products were held constant, approximating market price for the period (Table 16). The adjustments necessary to bring the farm factor allocations into conformity with the programmed solutions are shown in the various graphs in Figure 8.

In graph A of Figure 8, for example, it can be seen that in 1957, 16 farmers should have increased corn acreage whereas 8 operators should have reduced corn acreage. As mentioned earlier in this report, off-setting adjustments take place between individual units of the group. With all sample farmers at optimum corn acreage, the net increase for the group would have been 61 acres for 1957, at the product prices actually received by each farmer that year. A similar scrutiny of 1958[15] indicates that at prices received that year, 12 operators should have increased corn acreage but 8 others overplanted by enough to make the net result 40 acres of excess corn acreage for the group.

Other adjustments from the positive to the normative organizations can be seen in Figure 8. Generally, farmers had too much rotation pasture for the amounts of livestock necessary to optimize resource use, but had too little hay ground. It is interesting to note the recommended changes during the 1957-1959 period. The programmed solutions for 1957 called for dairy to remain about constant, a mild increase in feeder steer feeding, a substantial increase in spring sow farrowings, and a great increase in number of fall litters. In 1958, as price relationships changed, optimization entailed a severe reduction in numbers of dairy cows, a small increase in spring sows, an appreciable addition of fall sows, and a very large increase in feeder steers. In 1959 farmers should have dropped 77 of their dairy cows, reduced spring and fall farrowings by 163 and 58 litters, respectively, and added 1327 feeder steers to the numbers actually being fed. These solutions reflect the

[15]Each year's recommended enterprise increases or decreases are based on the enterprise size actually on the farms that year. They are independent of the existing or recommended amounts of the previous or succeeding year.

Fig. 8.—Recommended Enterprise Size Changes Necessary to Conform to Programmed Optimum Size, by Number of Farms, by Years

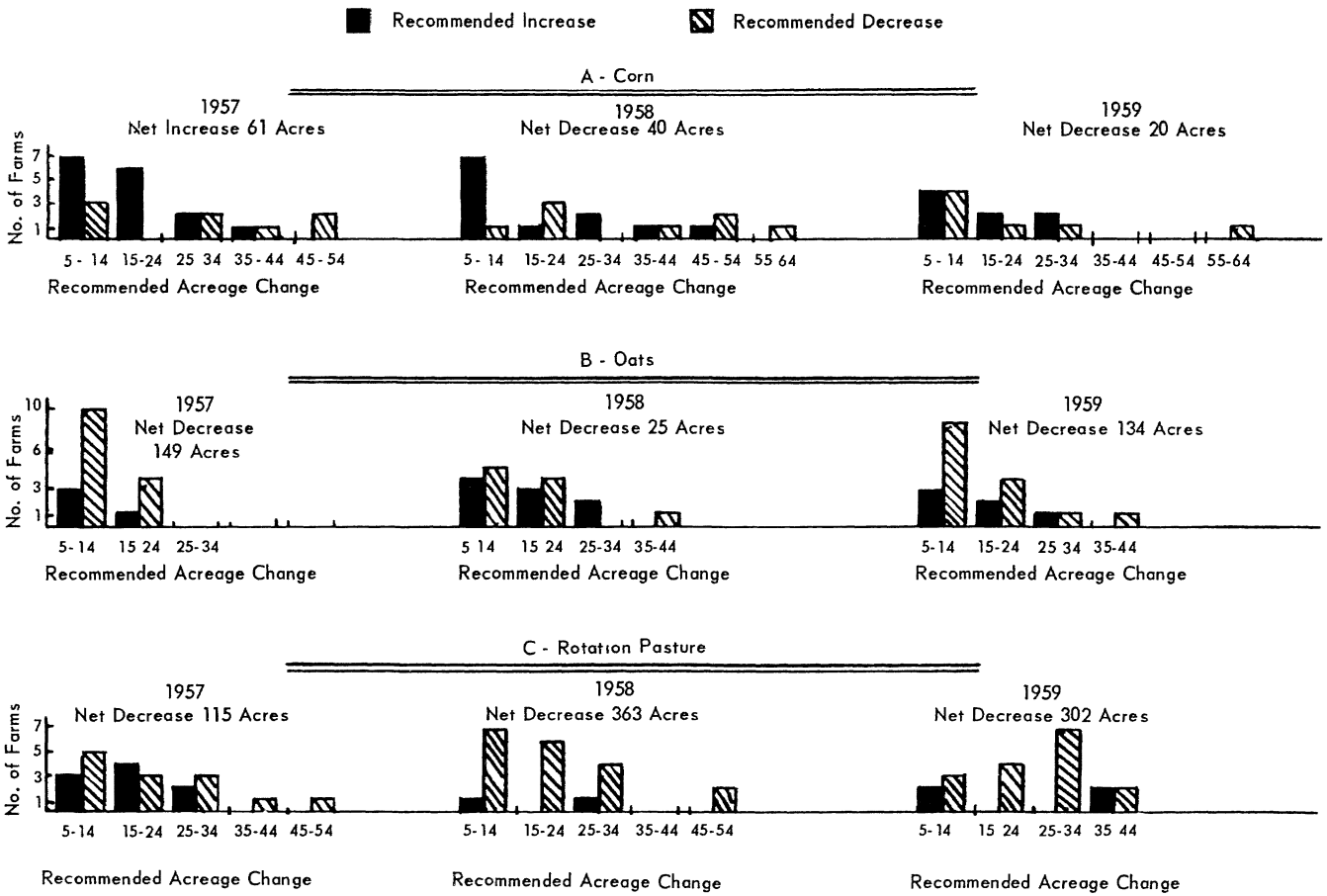


Fig. 8. (Continued)—Recommended Enterprise Size Changes Necessary to Conform to Programmed Optimum Size, by Number of Farms, by Years

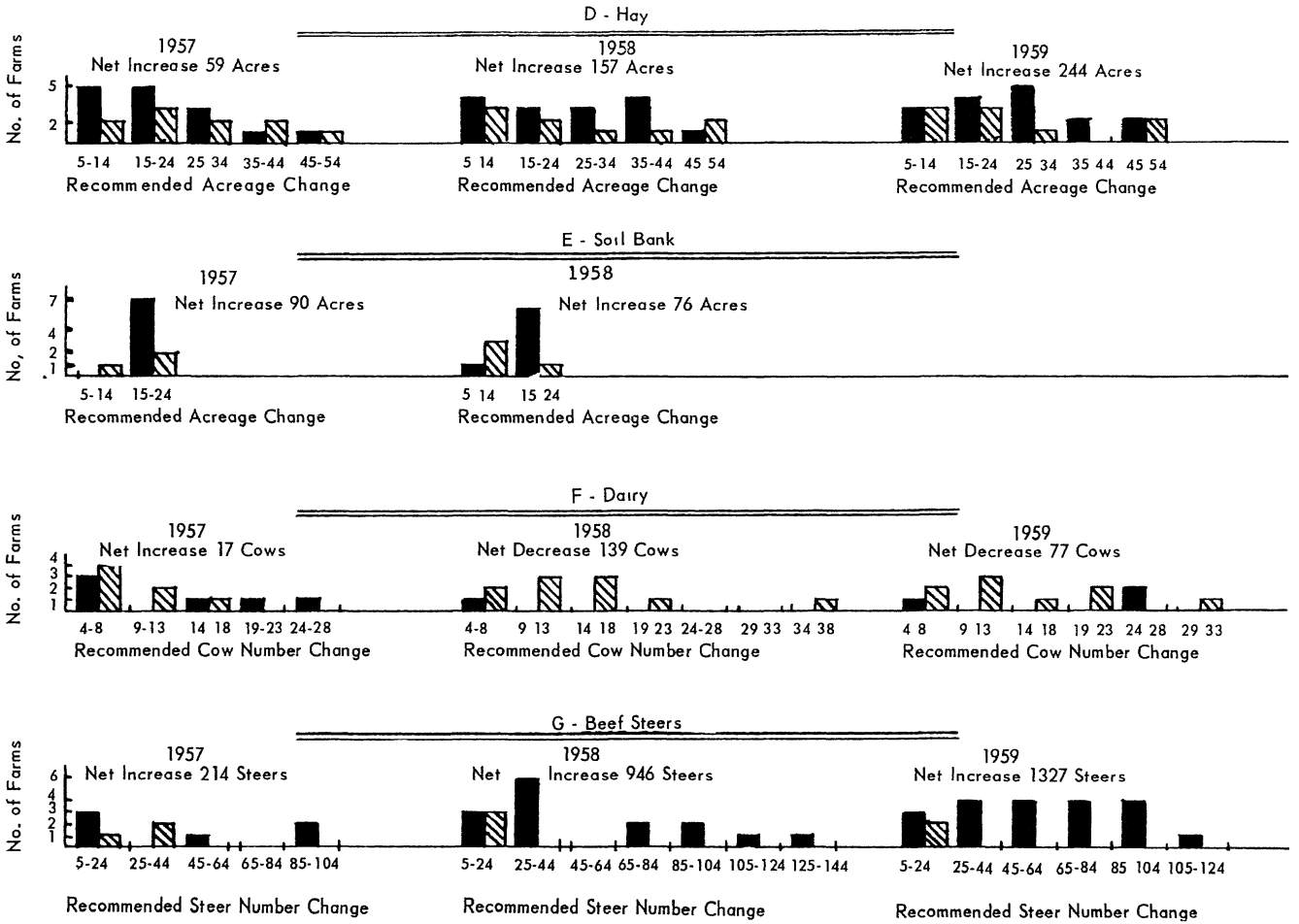
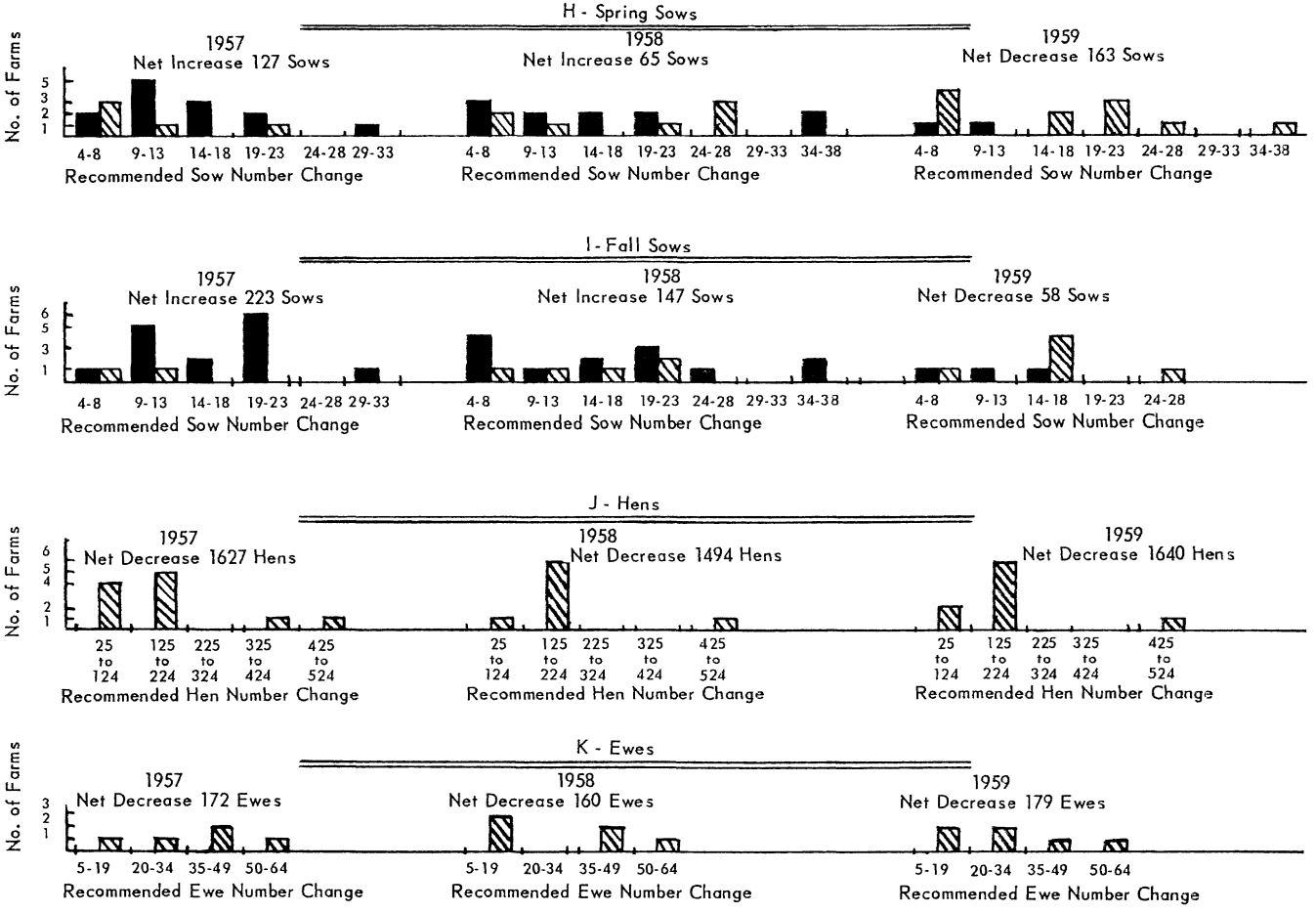


Fig. 8. (Continued)—Recommended Enterprise Size Changes Necessary to Conform to Programmed Optimum Size, by Number of Farms, by Years



relatively high fat beef prices in 1958 and 1959 and the $18 and $20 butcher hog prices in 1957 and 1958. The drop in hog price to $15 in 1959 led to the reduction in farrowings shown in the programmed optimums. Milk price was held at $3.95 net for grade A during the three-year period.

The prevailing prices of hens, eggs, lambs, and wool in 1957 through 1959 were low enough, relatively, that the programs totaled a recommended decrease of 1627, 1494, and 1640 hens and 172, 160 and 179 ewes, respectively, on the sample farms.

No recommended adjustments in land, capital, or labor appear directly in the programmed solutions, other than the implication of the unused capital and labor shown in the solution. Unused resources are shown separately in the final worksheets (example shown in Appendix B).

The mean amount of beginning capital was $13,824 for the 25 farms, ranging from $1200 to $27,000. Three farms had less than $5000 and five others were between $5000 and $10,000. Six operators had $20,000 or more available capital. In 1957, seven of the programmed solutions required less capital than the operators possessed and the other 18 optima utilized all the available capital. Higher variable incomes were achieved on these seven farms through proper resource allocations with about $5100 per farm less required capital. In 1958 and 1959 five programmed solutions produced higher incomes with $42,000 and $32,000 less total capital. The analysis did not include the alternative of providing more capital than the operator controlled, so no conclusions are available on the marginal productivity of additional capital.

Income Differences Between Actual Organization and Programmed Organization

In the programming process, fixed costs were not included in the model but were added later.[16] Perquisites were also added subsequently. Value of unpaid family labor was not taken out. Thus, the income derived from programming is actually a net variable income for the farm family. The income from the actual farm organization was also modified to approximate net variable income, and thus was comparable to the programmed results. Annual family net variable income per farm averaged $7925 for the 25 programmed optima and $3737 for the 25 actual farm organizations, a difference of $4188. This was statistically significant at the .01 probability level when the "t" test was used ($t = 15.77$, $df = 74$).

[16]An example of this is shown in the worksheet presented in Appendix B.

The above analysis used different production and cost coefficients in the program than the 25 operators actually used because the matrix values were modes and means of a four-year farm history for each farm whereas the production and price coefficients associated with the actual organizations were those occurring in each year with the particular resource combinations employed by the sample farmers in each of the three years (1957-1959). To test the amount of annual net variable income difference due primarily to coefficient differences, the price and production coefficients used in each programming matrix were substituted into each actual farm organization for each year. The mean annual income for the 25 farms for the three years increased $1730, from $3737 to $5467 per year. This left $2458 ($7925 minus $5467) as the loss of family variable income due to difference between the average annual actual resource allocation and the programmed optimum factor use. This income difference tested significantly large at the .01 probability level ("t" = 11.35, df = 74) when a paired difference group comparison was made.

In an effort to find specific variables associated with the income differences between programmed and actual resource allocation, a multiple correlation was run using net variable income differences as the dependent variate. It was found that the differences were positively and highly correlated with increase in corn acreage, inclusion of more beef steers in the farm plan, feeding efficiency and cash cost efficiency. It was also found that under the hog, beef, and milk prices used, reduction of dairy herd size would be beneficial on some of the farms. Dairy and beef enterprises correlated in a highly significant, but inverse, manner. These correlations were very consistent with results obtained in aggregation analysis in which the programmed solutions favored increase of hogs and beef feeders and a decrease in dairy under the price relationships existing during most of the 1957-1959 period. In Ohio Bulletin 885[17] dairy type farms showed a substantially lower rate earned on owned capital and a lower family income in 1956 than did the hog and general livestock type farms. Apparently the dairy farmers of Ohio agreed with the programmed decrease of dairy inasmuch as they decreased dairy cow and heifer inventories from 930,000 head in 1957 to 765,000 head in 1960.[18]

[17] "Resource Use on Four Types of 160-Acre Farms in West Central Ohio, 1956." Tompkin, J. R., Ohio Experiment Station Bulletin 885, July 1961.

[18] "Cows and Heifers, 2 and Over, Kept for Milk." Ohio Agricultural Statistics, 1958, 1959, 1960, and 1961. U.S.D.A.

AGGREGATIVE ADJUSTMENTS

The total suggested adjustments in resource use for the sample group of 160-acre farms were shown in Figure 8. They are simply the summation of the recommended shifts in resource use on each individual farm as shown by the programmed solutions.

One of the stated objectives (number 7 on page 8) of the overall project was to evaluate adjustments in terms of effect on production in the larger area of the nine-county project area, in western Ohio, and in the eastern segment of the Corn Belt itself. Expansion of 160-acre sample data alone cannot accomplish this because of the liklihood that different production functions are associated with different farm sizes. Adjustment research on other farm sizes is in progress, and when completed should furnish the information needed for analysis of aggregative adjustments.

OBSTACLES TO ADJUSTMENT

During the course of data collection, discussions with cooperators, analysis and interpretation, several deterrents to adjustment have been noted. The following discussion is, of necessity, a combination of subjective observations and evaluations of the authors and objective results of data analysis. The following factors appear to obstruct adjustment in varying degrees on the sample farms.

Rigidity of resources constitutes an effective barrier to major short-term adjustment. High fixed costs and specialized investments make enterprise changes more costly and operators appear to take less adjustment action unless they have the reassurance of forward pricing or feel that some permanency is attached to new price relationships.[19] The analysis in this report has indicated that adjustments are associated with the capital, net worth and equity position of the operator, with the number of PMWU's on the farm, and with the amount of cash operating costs per PMWU. These same variables are associated with farm resource flexibility as measured in terms of the number of price map areas of the programmed farm.

Percentage of land in cropland influences the profitability of enterprise changes between different types of livestock and particularly of changes involving deletion of livestock enterprises.

The risk-bearing position of the operator tends to force him into a safer, but often less profitable, position which he cannot leave because of external resource rationing.

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[19] "Response of the Farm Production Unit As A Whole to Prices." Tompkin, J. Robert, Journal of Farm Economics, Vol. XL. No. 5, December 1958

Adjustments themselves frequently serve as deterrents to adjustment. It was observed in the data that one type of adjustment frequently necessitates other adjustments. Thus the cost of the magnitude of the total change often stops the initial partial change.

Voluntary capital rationing was reported by many sample farmers as a major cause prohibiting adjustments which the operator himself felt would be profitable.

During the interviews the authors repeatedly were confronted with reluctance of the operator to make adjustments because of his desire to maintain a fixed **crop rotation.**

Lack of knowledge of alternative resource uses was frequently given by operators for adhering to given enterprise combinations even in the face of adverse price and/or cost relationships.

Age of the operator correlated negatively with machinery adjustment.

Several operators reported inability to adjust because of **tenure arrangements** in which the capital resources were controlled by a senior, more conservative, partner.

Excess family labor frequently deters adjustments in which labor could be replaced by capital resources. This affects certain livestock, machinery, and technological adjustments.

Size of farm prohibits many types of adjustment which operators would like to make but do not because of insufficient volume to make the change economically feasible. This is a frequent point brought up by cooperators in this study.

Undue emphasis on timeliness has kept many of the operators with major harvesting machines which they cannot justify in light of small volume of use, the availability of custom machines, and the degree of risk-loss normal to the area. Some operators have increased use-volume by performing off-farm custom work, but other operators continue to pay excessive per-acre harvesting costs through ownership.

A long-run pessimistic outlook kept several of the operators from making adjustments which they admitted should have been made. The 25 sample farmers were asked in the spring of 1960 what they expected prices and costs to be in 1965 relative to 1959. Seventeen operators expected from five percent to 30 percent increase in farm costs, but only 6 expected higher corn prices, 6 felt milk prices would increase, and seven and three operators respectively, predicted increases

in the prices of hogs and beef. Thus, most of the operators felt they would be relatively worse off in 1965 than in 1960. It was observed that cost control became more strict on many of the farms in 1958 and 1959 than had been true prior to that time. Cost level and number of adjustments were significantly associated in the correlation analysis done in this study.

APPENDIX A.—Linear Programming Matrix Showing Resource Use, Alternatives and Restrictions, Sample 160-Acre Farm Shown in Table 18.[1]

Kind of Resources Available	Unit	Amount	Hogs (Cwt)	Beef (Cwt)	Poultry (Hen)	Sheep (Ewe)	Dairy (Cow)	Corn (A)	Oats (A)	2-Cut Hay (A)
Corn Ground	Acre	40						1		
Oats Ground	Acre	5							1	
Meadow Ground	Acre	40								1
Corn	Bu.		7.06	8.00	.84	2.5	32	—70		
Oats	Bu.		2.17	1.00	.28	2.0	19		—47	
Hay	Ton			.16		.4	4.0			— 2.2
June Rotation Pasture	A.U.D.		.64			7.0	38.0			
July Rotation Pasture	A.U.D.		.64			7.0	38.0			
Permanent Pasture	Acre	13								
Capital	Dollar	12800	10.49	27.66	7.58	23.43	499.60	34.84	28.40	22.55
April Labor	Hour	347	.25	.30	.3	2.0	9.2	1.2	2.6	.1
June Labor	Hour	347	.14		.3	.3	7.2	.3		3.1
October Labor	Hour	358	.24	.15	.2	.3	8.7	3.0		
Good Housing	Sq. Ft.	12000	3.61		3.5		100			
Fair Housing	Sq. Ft.	400		6.00		15.0				
Soil Bank	Acre	20								
Net Income (CJ)	Dollar	——	Variable Prices[2]		.10	11.19	191.77	—36.58	—29.82	—23.68

[1]Dis-use and transfer vectors not shown.

[2]Hog and beef prices were permitted to vary; thus, these CJ's will also vary. They represent the net returns per hundredweight after substraction of variable costs and those fixed costs directly associated with special hog and beef equipment.

APPENDIX A. (Continued)—Linear Programming Matrix Showing Resource Use, Alternatives and Restrictions, Sample 160-Acre Farm Shown in Table 18.

Kind of Resources Available	1-Cut Hay (A)	Rotation Pasture (A)	Permanent Pasture (A)	Soil Bank (A)	Buy Corn (Bu)	Sell Corn (Bu)	Buy Oats (Bu)	Sell Oats (Bu)	Buy Hay (T)	Sell Hay (T)
Corn Ground										
Oats Ground										
Meadow Ground	1	1								
Corn					—1	1				
Oats							—1	1		
Hay	— 1.5								— 1	1
June Rotation Pasture		—32	—26							
July Rotation Pasture	—14	—24	— 7							
Permanent Pasture			1							
Capital	17.77	8.00	3.33	3.00	1.22		.72		21.00	
April Labor	.1	.1		1.00						
June Labor	3.1	.1		.50						
October Labor										
Good Housing										
Fair Housing										
Soil Bank				1						
Net Income (CJ)	—18.66	— 8.40	— 3.50	50.00	—1.22	1 15	— .72	.64	—21.00	20.00

APPENDIX B.—Derivation of Family Labor Earnings from Optimum 1958 Programmed Solution Shown in Table 18.

Activity	Unit	Optimum Amount	Total Feed Used and Produced			
			Corn	Oats	Wheat	Hay
			Bu.	Bu.	Bu	Ton
Beef Steers	Str	73	2940	3617		59
Corn	Acre	42	2940*			
Oats	Acre	5		235*		
Wheat	Acre	15			450*	
Two-Cut Hay	Acre	40				88*
Soil Bank	Acre	18				
Buy Oats	Bu	132				
Sell Hay	Ton	29				
Sell Wheat	Bu	450				
Permanent Pasture Used	Acre	13				

*Items produced are marked with an asterisk; those used are not so marked.

APPENDIX B. (Continued)—Derivation of Family Labor Earnings from Optimum 1958 Programmed Solution Shown in Table 18.

Activity	Resources Used									Income	
	Cropland	Capital	June Rotation Pasture	July Rotation Pasture	April Labor	June Labor	October Labor	Good Housing	Fair Housing	Per Unit	Total
	Acre	Dollars	A U.D	A.U.D.	Hour	Hour	Hour	Sq. Ft.	Sq. Ft.	Dollars	Dollars
Beef Steers		10151			110		55	2920		99.05	7270
Corn	42	1463			50	13	126			—36.58	—1536
Oats	5	142			13					—29.82	— 149
Wheat	15	499				4	27			—34.93	— 524
Two-Cut Hay	40	902			4	124				—23.68	— 947
Soil Bank	18	54			18	9				50.00	900
Buy Oats		95								— .72	— 95
Sell Hay										20.00	580
Sell Wheat										2.00	900
Permanent Pasture Used		43	338*	91*						— 3.50	— 46
Resources Not Used			338	91	52	97	50	9080	400		

Value of House Rental and Garden	677
Total Farm Earnings	7030
Taxes and Depreciation on Land, Bldgs., Mach.	3633
Interest on Owned Capital in Land, Bldgs., Mach.	1943
Family Labor Earnings	1454

*Items produced are marked with an asterisk; those used are not so marked.